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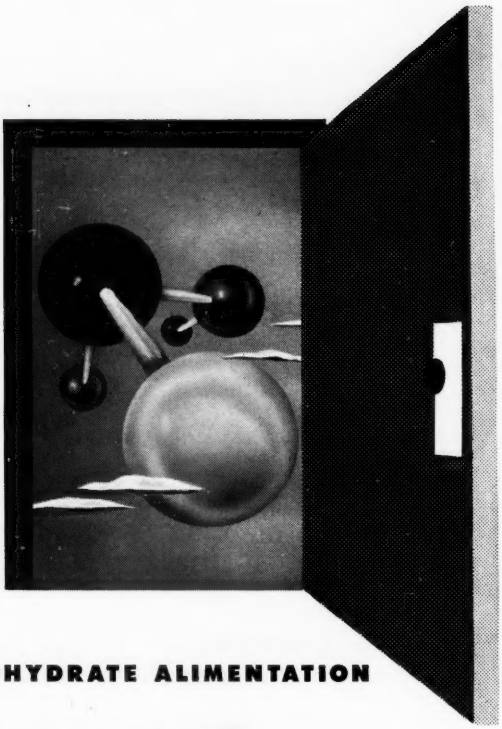

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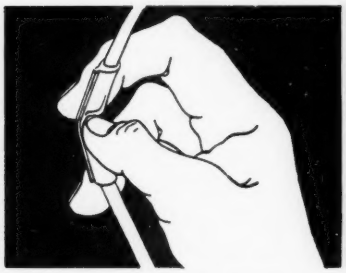

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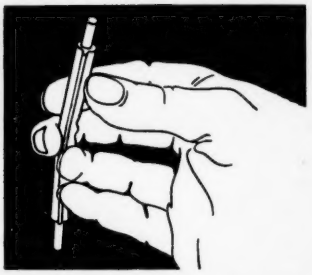

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SURGERY
GYNECOLOGY AND OBSTETRICS

VOLUME 94 MAY, 1952 NUMBER 5

THE HEMATOLOGIC RESPONSE OF THE PREGNANT WOMAN TO INTRAVENOUS SACCHARATED IRON OXIDE

D. B. NICHOLSON, M.D., and N. S. ASSALI, M.D., Cincinnati, Ohio

ALTHOUGH the etiology of anemias in pregnancy has been the subject of much discussion, it has been generally accepted that iron deficiency anemia is a common finding in the pregnant woman (6, 10, 17). The treatment of this entity has been dealt with by several authors with different agents (5, 14, 22). Within recent years there has been increased interest in the use of intravenous saccharated iron oxide as an agent which will restore rapidly the iron deficit of the pregnant woman. The factors which favor the use of this type of treatment are the following: (a) Iron deficiency anemia is the most common anemia in pregnancy (6, 10, 17); (b) many pregnant women in the out-patient departments are not seen until the last trimester of pregnancy; (c) in the normally pregnant woman, intestinal absorption of iron is low (11); thus a prolonged treatment period with oral iron may be necessary to correct iron deficit when it exists.

The present set of experiments were designed in order to study the hematologic response of pregnant and recently delivered subjects, with and without manifest anemia, to acute intravenous injections or continuous intravenous infusion of saccharated iron oxide. It was hoped that a method for rapid correction of this type of anemia might be found.

From the Department of Obstetrics, University of Cincinnati College of Medicine and the Cincinnati General Hospital, Cincinnati, Ohio.

MATERIAL AND METHOD

The material included in this study consisted of the following groups of patients:

Group A.—4 patients whose hemoglobin level was above 10.0 grams per cent. These patients were considered normal and served as controls.

Group B.—6 prepartum anemic patients whose pretreatment hemoglobin varied between 8.0 and 10.0 grams per cent.

Group C.—6 postpartum and postabortal patients whose pretreatment hemoglobin varied between 5.7 and 9.8 grams per cent.

Group D.—Other patients were given this drug but were excluded from this study because of failure to appear at scheduled times either for injection of this drug or for follow-up examinations. They are mentioned here only because they are included insofar as toxic reactions are concerned. These side effects will be discussed later in this paper.

The detail of clinical data on these patients is given in Table I; some of the patients were on the ward at bed rest; others were studied as out-patients and were requested to report to the laboratory at thrice weekly intervals.

The following method was adopted for the study: (1) Levels of the hemoglobin, erythrocyte count, packed cell volume, reticulocyte

TABLE I.—CLINICAL DATA

Group	No. patients	Mean age, years	Mean parity	Mean gestation before treatment, weeks
A	4	29.0	2.8	33
B	6	21.2	1.0	31
C	6	27.5	2.8	..

count and peripheral blood smear were taken on two occasions before treatment was initiated and served as a control. (2) Iron administration was then initiated. During this time and thereafter, the same determinations with the exception of the blood smear were repeated at least once every week during and following the completion of therapy, within 10 days of delivery and 6 weeks postpartum.

The individual determinations were done as follows:

Hemoglobin: This determination was done as oxyhemoglobin on a Coleman junior spectrophotometer (12). The hemoglobin values for this instrument had been previously determined by oxygen saturation studies of successively diluted whole blood. A normal hemoglobin was taken empirically to equal 14.5 grams per cent.

Erythrocyte count: This was done by standard methods using standard pipettes and Spencer bright line improved Neubauer counting chambers.

Packed cell volume: This was done according to the method of Wintrobe (19), the anticoagulant used being that described by the same author (20).

Reticulocyte count: This was done by a standard method using Dameshek's solution (21).

Peripheral blood smear: This was performed by the cover glass technique using Wright's stain for fixing and staining smears.

Patients were diagnosed as being anemic when their blood studies showed any or all of the following criteria: (1) hemoglobin levels of less than 10.0 grams per cent; (2) erythrocyte counts which were less than 3.5 million per cubic millimeter; (3) packed cell volumes which were less than 32.0 volumes per cent. Not all of the patients had purely microcytic anemias; in the postpartum and postabortal group, particularly, the subjects selected had acute blood loss which was a contributing factor to their anemia. These patients received no blood transfusions.

TABLE II

1. Normal hemoglobin = 14.5 gm./100 ml. whole blood
2. Blood volume = 5,000 ml.
3. 1.0 gm. hemoglobin contains 0.00339 gm. elemental iron (18)
4. Hemoglobin deficit × 50 × 0.00339 × 1000 = blood iron deficit
5. Storage deficit iron = 800.0 mgm.
6. (4) plus (5) above = total iron deficit (mgms.)

The iron was given in most instances directly into the patient's vein in dosage of 200.0 milligrams in the form prepared commercially as a saccharated iron oxide in 2.0 per cent solution. The administration of this drug was generally carried out on alternate days, usually 3 times weekly to observe the response as one might expect it in office practice. In the great majority of patients the maximum single dose was 200.0 milligrams, although in 1 patient 400.0 milligrams was given once. In the postpartum and postabortal group this 200.0 milligram dose was given once initially by mixing a single dose of iron in 1,000 cubic centimeters of 5 per cent glucose in saline and giving it as an intravenous drip. A similar method was used in 4 other patients who were excluded from this study. These are mentioned here for their side effects which will be reported later in this paper. In any given patient, the dose was given slowly over a minute to a minute and one-half and the solution of saccharated iron oxide intermixed with the venous whole blood by drawing back and forth on the syringe as the solution was administered.

CALCULATION OF DOSAGE

For the purposes of this study all patients in group A were arbitrarily given 1,000 milligrams of saccharated iron oxide. Dosage of iron in groups B and C was calculated according to the formula presented in Table II.

RESULTS

The results are shown in Figures 1 to 6. Figures 2, 4, and 6 are individual examples of patients treated. In each of the latter figures there is listed the hemoglobin, erythrocyte count, and reticulocyte count before and after the iron administration, the length of time of iron administration, and the number of injec-

tions. Figures 1, 3, and 5 depict the mean response of each group.

Group A (control group). In this group the pretreatment hemoglobin varied between 11.8 and 12.9 grams per cent. In this group there was a mean rise of 0.7 gram per cent by the time therapy was completed (8 to 21 days prepartum); a further rise of 0.5 gram per cent was observed in the postpartum period. The pretreatment erythrocyte count varied between 3.87 and 4.53 million per cubic millimeter and averaged 4.25 million per cubic millimeter. The final erythrocyte count postpartum averaged 4.25 million per cubic millimeter; thus, there was no net gain in red blood cells (Figs. 1 and 2). The pretreatment packed cell volume varied between 38 and 42 volumes per cent, and averaged 40 volumes per cent. The mean reading postpartum—following completion of therapy—was 43.5 volumes per cent. There was a small but discernible reticulocyte response in all patients. The average maximum reticulocyte response was 3.0 per cent.

Group B (prepartum anemic patients). The pretreatment hemoglobin values in this group varied between 8.0 and 10.0 grams per cent and averaged 9.4 grams per cent. Following treatment, the mean hemoglobin rose to 11.4 grams per cent; a net gain of 2.0 grams per cent was achieved. The pretreatment erythrocyte counts in this group varied between 2.59 and 4.51 million per cubic millimeter, an average of 3.61 million per cubic millimeter. In the puerperium after treatment, the erythrocytes averaged 4.15 million per cubic millimeter. The pretreatment packed cell volume varied between 26 and 33 volumes per cent and averaged 31 volumes per cent. After the iron therapy and in the puerperium the packed cell volume averaged 40 volumes per cent. Thus, a net gain of 9.0 volumes per cent was observed in this group. The maximum reticulocyte response varied in this group of patients between 3.7 and 6.6 per cent and averaged 5.3 per cent.

Group C (postpartum and postabortal patients). The pretreatment hemoglobin varied between 5.7 and 9.9 grams per cent and averaged 7.6 grams per cent. Four to 6 weeks following the completion of treatment the

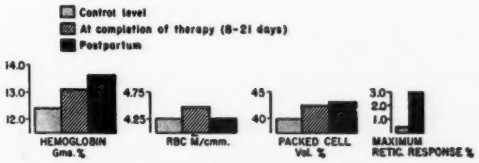

Fig. 1. Mean response of 4 prepartum control patients. The hemoglobin in these patients was greater than 10 grams per cent. The mean length of gestation at the start of therapy was 33 weeks. Note the response of the hemoglobin in relationship to the lack of increase in the erythrocyte count. The maximum reticulocyte response is minimal.

mean hemoglobin was 13.0 grams per cent. The pretreatment red blood cell count varied between 2.40 and 3.85 million per cubic millimeter and averaged 3.06 million per cubic millimeter. Four to 6 weeks following the completion of therapy this had risen to an average figure of 4.31 million per cubic millimeter. There was, thus, a net gain of 1.25 million per cubic millimeter (Figs. 3 and 4). The pretreatment packed cell volume varied between 19 and 32 volumes per cent and averaged 25.5 volumes per cent. Four to 6 weeks following therapy the packed cell volume averaged 43.1 volumes per cent. A net gain of 17.6 volumes per cent was achieved. The reticulocyte response varied between 3.1 and 11.9 per cent; the mean response was 7.0 per cent in this group. The reticulocyte response was seen to occur immediately following the first day when infusion of saccharated iron oxide was started. The patients in this group were then

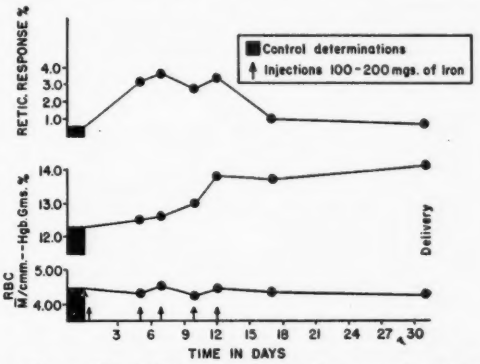

Fig. 2. The individual response of a control patient (D. E., prepartum, age 34 years) to intravenous iron is depicted. Note the increase in the hemoglobin as contrasted to lack of general response of erythrocytes.

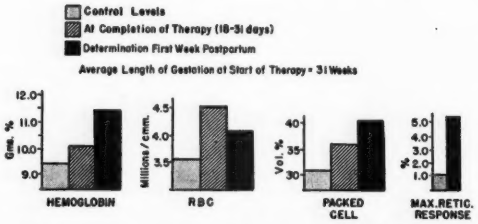

Fig. 3. Mean response of 6 prepartum patients (hemoglobin 8.0 to 10.0 grams per cent). Note the increase in all components studied, the greater maximum reticulocyte response in proportion to the degree of anemia as contrasted with the control group in Figure 1.

followed until there was a definite drop for 2 days before therapy was reinstituted (Figs. 5, 6, 7).

SIDE EFFECTS

There were 12 instances in a total of 203 injections in which reactions occurred, none of which was serious enough to warrant discontinuance of therapy. These side effects are categorized in Table III.

Local reactions consisted of superficial phlebothrombosis in 3 patients, pain at site of injection or along course of vein in 7 patients.

In general these were of little consequence and caused little if any difficulty with further administration of iron.

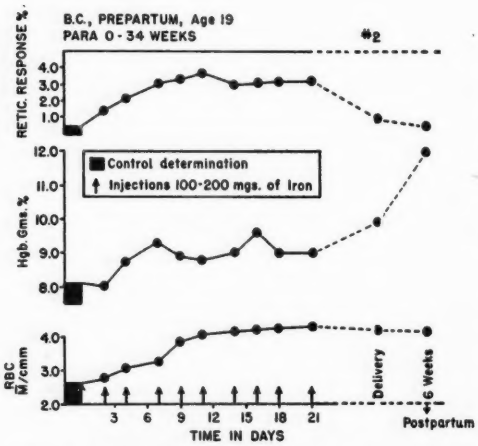

Fig. 4. Individual response of a prepartum anemic patient with normochromic normocytic anemia. This patient had a history of congenital kidney disease with previous unilateral nephrectomy. Pyelitis was present during this pregnancy prior to the start of therapy. Note the progressive reticulocyte response.

TABLE III

Dosage, mgm.	No. injections	No. local reactions	No. severe reactions
100			
150	20	1	0
200	180	9	1
300	2	0	0
400	1	0	1
	203	10 (5.0%)	2 (1.0%)

Severe reactions, which were observed in 2 patients following single injections, were characterized by the appearance within 10 minutes of the time of injection of a subjective feeling of intense burning throughout the body. In 1 patient who received 400 milligrams of iron this was followed by chills and a febrile reaction in which the temperature rose to 101.6 degrees F. This patient also experienced nausea. There were no manifestations of shock in either patient though in each case there was a temporary rise in the pulse rate. Both patients were able to resume therapy later at a lowered dosage schedule. There was 1 failure in therapy in a patient who was subsequently proved to have sickle cell anemia.

DISCUSSION

Historically, parenteral administration of iron was first attempted in the late twenties and early thirties (2). The preparations used at that time were active therapeutically but frequent toxic reactions precluded their administration except in the most severe types of microcytic anemia. In these cases oral therapy could not be tolerated or they were refractory to orally administered iron (13). As has been the case with many drugs which are too painful to be given by intramuscular or subcutaneous injection, a new type of intravenous therapy was adapted for human use and introduced by Nissim in 1947. This in essence is the drug that has been used subsequently in Great Britain and later in the United States.

Since that time there have been several articles dealing with the general subject of treating microcytic anemia with intravenous saccharated iron oxide (1, 4, 9, 14, 16). Some of these and other papers have denoted the

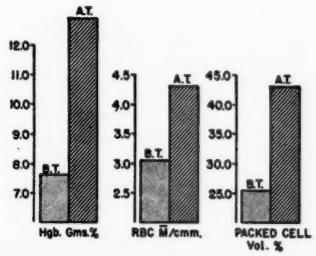

Fig. 5. The mean response of 6 postabortal and postpartum patients to intravenous iron. B.T., before treatment; A.T., levels 4 to 6 weeks after completion of therapy; average total iron oxide injected, 2,150 milligrams per patient. In this figure note the marked rise in all components. The mean maximum reticulocyte response (not shown here) in this group was 7.0 per cent, as might be expected from the severity of the anemia. Contrast this with the mean maximum response of reticulocytes in Figures 1 and 3.

pathologic possibilities that might result from excess iron administration. They have, in fact, decried the use of this drug except in certain patients in whom oral administration of iron is either unwarranted or not tolerated (1, 3). All essayists have noted that iron dosage should be calculated, taking into consideration the iron storage deficit as well as the hematologic deficit. With the above policy we are heartily in agreement. However, Hahn and his associates, using radioactive iron, have shown that the normal pregnant woman in the last trimester of pregnancy absorbs only 8.0 per cent of what may be considered a single oral therapeutic dose. On the other hand, Goetsch, Moore, and Minnich have shown (using intravenous colloidal ferric hydroxide and colloidal ferric oxide) that from 71.8 to 99.7 per cent of injected iron is apparently used for the synthesis of hemoglobin. Their dosage, however, was calculated to restore the circulating hemoglobin to normal levels only.

From this study it is suggested that saccharated iron oxide be used in at least two categories: (1) pregnant patients with a microcytic anemia seen late in pregnancy for their first visit; (2) patients with anemia due to acute hemorrhage.

The present study indicates that saccharated iron oxide therapy is immediately productive of erythropoiesis (Fig. 7), that relatively large amounts of iron may be given in a short period of time, that the average hema-

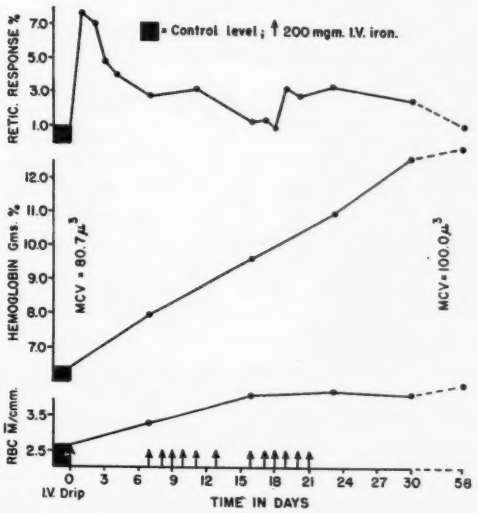

Fig. 6. Individual response of a postabortal patient with microcytic anemia. E.C., age 33 years; history of bleeding peptic ulcer; dilatation and curettage for 15 week incomplete abortion 2 days before therapy. This patient had an immediate response of reticulocytes to the 1st injection of saccharated iron oxide in an intravenous drip. Note also the rapid rise in hemoglobin of 6.2 grams per cent in 30 days. This was accompanied by a corresponding increase in this patient's subjective feeling of well being and by a release from her previous weakness and apathy.

tologic response is as rapid as that of oral iron and initially more rapid than may be achieved with orally administered iron. The response, in general, is inversely proportional to the degree of anemia existing before the start of therapy. The side effects are minimal in the dosage employed. The present data further demonstrate that it is practicable to give a patient saccharated iron oxide as a part of an

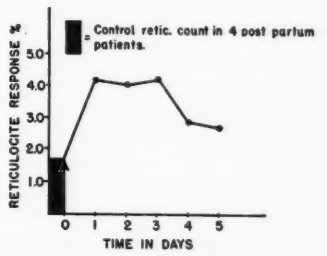

Fig. 7. Mean reticulocyte response of 4 postpartum patients to 200 milligrams of saccharated iron oxide in an intravenous drip. Average initial hemoglobin in 4 patients, 7.6 grams per cent. Note that the response is immediate.

intravenous drip postoperatively and we suggest its use preoperatively in patients with microcytic anemia.

However, despite the apparent safety in the dosage employed, we do not believe that it should be used routinely in obstetrical practice even though it was used in this study on patients who might well have been carried on routine oral preparations. We agree with Brown, Moore and Reynefarje, who state that intravenous iron should be used only in those patients with gastroenteric disease or with other intolerance to oral iron. This is true particularly in view of the findings by Finch and his co-workers who have demonstrated pathologically in animals the late results of excess iron administration.

SUMMARY AND CONCLUSIONS

1. The response to intravenous saccharated iron oxide of 4 control prepartum, 6 anemic prepartum, and 6 anemic postpartum patients is presented.

2. Saccharated iron oxide therapy promotes immediate erythropoiesis in patients with microcytic anemia in pregnancy.

3. The degree of response is, in general, inversely proportional to the severity of the anemia before treatment.

4. Saccharated iron oxide may be administered either by intravenous drip or by intermittent intravenous injections.

5. Intravenous saccharated iron oxide therapy is safe in the dosage employed, provided the total dose is calculated for each patient. In this way, side effects are minimal.

6. This form of iron therapy should be reserved for patients not suitable for oral iron therapy.

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LATE RESULTS AFTER TOTAL GASTRECTOMY

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THE possibility of increasing the curability rate of carcinoma in all parts of the body by more extensive and radical surgical procedures has evoked widespread interest during recent years. In line with this general trend in the surgical treatment of malignant growths, it has been repeatedly suggested that total gastrectomy constitutes the operation of choice in all cases of gastric carcinoma. Not all agree with this suggestion but, because of the increasing interest in total gastrectomy, it seemed of interest to us to ascertain, if possible, to what extent a patient thrives over a period of years without his stomach.

For this reason all cases in which total gastrectomy was performed at the Mayo Clinic in the years 1917 to 1948 inclusive have been reviewed. There were 185 cases in this group. Total gastrectomy was performed for a malignant lesion in 170 cases and for a benign lesion in 15 cases. In most of the latter cases, total gastrectomy was performed for a lesion which was suspected of being malignant but this suspicion was not substantiated by subsequent histologic study. Only those cases were reviewed in which the pathologist observed esophageal tissue on one end and duodenal tissue on the other end of the surgical specimen. As many patients as possible were studied 5 or more years after operation. Although the main object of this study was to evaluate late results after operation, observations are included on certain other points that appeared to be of concomitant interest. This study does not bear directly on whether routine use of total gastrectomy in all cases of gastric carcinoma would increase ultimate survival rate.

AGE AND SEX

Three quarters (74.5 per cent) of the entire group of patients were men. The youngest patient was 30 years of age and the oldest was aged 92 years. The latter patient was operated on by our associate, O. T. Clagett, and to our knowledge is the oldest patient successfully subjected to total gastrectomy. Incidentally, this patient had an ulcerating esophagogastric lesion which, on histologic study, proved to be benign.

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SURGICAL TECHNIQUE

Surgical technique, as well as operative mortality and survival rates early after total gastrectomy, has been discussed in many articles. Some years ago there appeared reports by Schlatter, Brigham, Richardson, MacDonald, Harvie, Moynihan, Dollinger, Mayo, Finney and Reinhoff. In more recent years, numerous other reports have appeared. Although the operative technique of total gastrectomy will not be considered in detail at this time, an attempt was made to learn if one particular type of operation was associated with a lower operative mortality than other types. This is difficult to determine accurately, in view of the fact that the patients considered were operated on in the course of approximately 30 years. Obviously, during such a period, many factors other than technical ones have influenced operative mortality. The technique of total gastrectomy performed through the abdominal approach has been described by numerous authors. Others have been interested in the thoracico-abdominal approach which was first employed successfully by Meyer in 1942. An abdominal incision was used in 182 cases of the present series of 185 cases. A thoracic approach was used in 3 cases. It is our opinion that the transthoracic approach for total gastrectomy is seldom indicated. In some cases a thoracico-abdominal approach may offer the best exposure.

Gastrointestinal continuity was established after removal of the entire stomach by anastomosing the end of the esophagus and a loop of the jejunum in 89.2 per cent (165) of the 185 cases. Esophagoduodenostomy was per-

TABLE I.—SOME MORTALITY RATES REPORTED FOR TOTAL GASTRECTOMY

Author	Year	No. of patients	Mortality, per cent
Finney and Reinhoff	1929	67	53.8
Graham	1940	19	73.6
Walters, Gray and Priestley (29)	1942	27	66.7
Pack and McNeer	1943	298	37.6
Horsley	1943	15	80.0
Lahey and Marshall (13)	1944	73	33.3
Waugh and Fahlund	1945	77	44.2
Longmire	1947	20	10.0
Smith	1947	89	29.1
Walters, Gray and Priestley (30)	1948	19	5.3
Wangensteen	1949	28	3.5
Scott and Longmire	1949	63	9.5
Lahey and Marshall (14)	1950	64	9.4
Finsterer	1950	103	49.5

formed in 8.1 per cent (15) of the cases and some other type of anastomosis such as a Roux-Y procedure was employed in the remaining cases. The operative mortality was 30.9 per cent in the cases in which an esophagojejunal anastomosis was established. In the relatively small group (15 cases) in which an esophagoduodenal anastomosis was made the operative mortality was 20 per cent. The significance of this difference seems open to question for several reasons. In the first place, the cases in which the esophagus and duodenum were joined were relatively few and, in the second place, a relatively large proportion of the patients were operated on in recent years. In properly selected cases, however, anastomosis of the esophagus and duodenum is satisfactory.

Many surgeons, when they perform an ordinary loop type of esophagojejunal anastomosis after total gastrectomy, routinely employ jejunojejunostomy. Some surgeons, however, do not employ this procedure. There are certain advantages and disadvantages with both techniques. Of the present series of 165 cases in which the usual type of esophagojejunal anastomosis was made, in 64.3 per cent anastomosis was established between ascending and descending limbs of the jejunum. The operative mortality was identical whether or not such an anastomosis was employed.

Some form of postoperative intestinal intubation frequently is used when total gastrectomy is performed. In earlier years, a jejunal stoma often was established at the time of operation. This procedure is now used infrequently but, instead, an indwelling nasal catheter may be passed into the jejunum. Of the present series of 185 cases, in 27 per cent a jejunostomy tube was inserted at the time of operation. In 43 per cent of cases an indwelling nasal catheter was employed and in 30 per cent of cases no form of intubation was employed. A relatively high operative mortality was found in the cases in which jejunostomy was performed, probably because it was in the earlier cases in which this was a routine procedure. The operative mortality was virtually identical whether an indwelling nasal catheter or no tube was employed.

PATHOLOGIC ASPECTS

Obviously, the type of lesion which is removed is significant in any study of late results. A "diffuse" lesion involved virtually the entire stomach in 50 per cent of the 170 cases in which the growth was malignant. In 41 per cent of the 170 cases only the upper half of the stomach was involved, whereas only the lower half of the stomach was involved in 5 per cent of the cases. Multiple malignant lesions were found in 4 per cent. In 2 cases there proved to be both a benign and a malignant lesion. Serosal involvement by the malignant process was demonstrated in 77 per cent of cases. Regional lymph nodes were involved in 78 per cent of cases.

Extension of the malignant process to neighboring structures was found in 38 per cent of the cases. Adjacent structures which were involved most often were the omentum, esophagus, pancreas, hilus of the spleen, liver, and transverse colon. Less often evidence of involvement was found in the jejunum, diaphragm, abdominal wall, duodenum, and transverse mesocolon. Multiple adjacent structures were involved in some cases. In 10 per cent of cases there was no evidence of extension of the malignant process beyond the stomach.

Grading of the malignant lesions after the method of Broders revealed that lesions of grade 4 comprised 66 per cent of the series,

while 22 per cent were of grade 3, 9 per cent were of grade 2, and only 3 per cent were of grade 1. Of the 170 malignant lesions, 155 were adenocarcinomas. There were 7 cases of lymphosarcoma and 3 cases of leiomyosarcoma. In addition to these, there were 2 cases each of squamous cell epithelioma and of small cell carcinoma, and 1 case of lymphoblastoma.

Among the 15 benign lesions were 13 inflammatory ulcers, 4 of which were multiple. There were 2 cases of Menetrier's disease, in one of which an inflammatory ulcer also was present.

OPERATIVE MORTALITY

As is well known, the operative mortality of total gastrectomy was extremely high in former years, as it was also in the earliest years of partial gastrectomy. In more recent years the risk of total gastrectomy has been materially lowered as has the mortality of virtually all other surgical procedures. It seems highly questionable, however, if the risk of total gastrectomy over the country as a whole ever will become as low as that for partial gastrectomy. Certainly this is not the case at present, although a few experienced surgeons have reported a remarkably low mortality for total gastrectomy in a relatively small series of cases (Table I). Figure 1 represents the gradual reduction of operative mortality after total gastrectomy at the Mayo Clinic during a period of years. In the 5 years from 1945 to 1949 inclusive, total gastrectomy was performed in 108 cases, with 14 deaths; the mortality rate, therefore, was 12.9 per cent.

As might be expected, the mortality rate was highest if the lesion involved the entire stomach. In this regard, it made no difference whether involvement was of the upper or lower half of the stomach. The presence or absence of involvement of lymph nodes and serosa did not appear to affect the operative mortality rate. Peritonitis and pulmonary complications have been the most frequent causes of death.

LATE RESULTS

There have been few reports of late results after total gastrectomy. Lahey (12) reported a 3 year survival rate of 21 per cent. One patient was alive 12 years after operation and "several for lesser periods of time." Smithwick reported 2 five year survivors. Finsterer reported on 9 patients who survived for 5 years after operation.

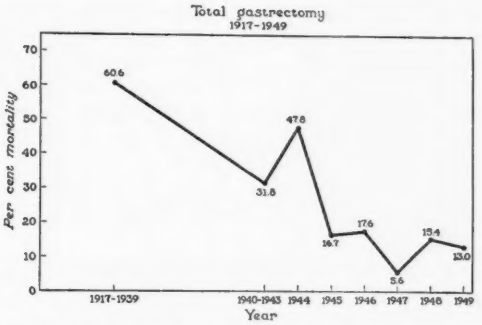

Fig. 1. The gradual reduction of operative mortality after total gastrectomy.

Survival rates in the present study are shown in Table II. It is noted that the survival rate following complete removal of the stomach for benign disease is relatively high. Eight of 9 patients who were traced lived for 3 years and 4 of 6 patients who were traced lived for 5 years. In contrast, only 17 of 80 (21 per cent) traced patients, each of whom had a malignant lesion of the stomach, survived 3 years after operation and 9 of 50 (18 per cent) traced patients lived 5 years after operation. In the relatively extensive type of malignant disease for which total gastrectomy was performed in this series of cases, it therefore seems likely that if recurrence resulting in death is going to occur, it probably will occur within 3 years after operation.

One of the patients who lived for 5 years after total gastrectomy had a lymphosarcoma of the stomach and the remainder had adenocarcinoma. It is of interest that total gastrectomy was performed for a malignant lesion in the lower half of the stomach in 10 cases and that in only 1 of these cases did the patient live for 5 years after operation, a survival rate of only 10 per cent. This suggests that if the growth is in the distal portion of the stomach, complete removal of the stomach offers no more chance for long survival than if adequate subtotal gastric resection is performed.

TABLE II.—TOTAL GASTRECTOMY: THREE YEAR AND FIVE YEAR SURVIVAL RATES

Type of lesion	No. of patients		Lived 3 or more years after leaving hospital		No. of patients		Lived 5 or more years after leaving hospital	
	Total	Traced	Number	Survival rate, per cent*	Total	Traced	Number	Survival rate, per cent*
Benign	9	9	8	88.9	7	6	4	66.7
Malignant	81	80	17	21.2	50	50	9	18.0

*Per cent of traced patients. Inquiry as of January 1, 1950. The 3 year group includes patients operated on 3 or more years prior to the time of inquiry; that is, 1946 or earlier; the 5 year group includes those operated on in 1944 or earlier. Hospital mortality is excluded in calculation of the survival rates.

There was neoplastic involvement of the regional lymph nodes in 44.4 per cent, and serosal involvement in 66.6 per cent, of cases in which the patients survived 5 years after operation. These figures are in contrast with those for the group of cases in which total gastrectomy was performed for malignant disease. Of those 170 cases, as has been said, lymph nodes were involved in 78 per cent, and the serosa in 77 per cent.

Study of the grade of malignancy (Broders) revealed that the lesions of 75 per cent of patients who survived 5 years were of grade 1 or grade 2. The lesions of 25 per cent were of grade 3. None of the lesions of those who survived 5 years was of grade 4. This is in sharp contrast with the group of 170 patients who had malignant lesions, of whom 85 per cent had lesions of grade 3 or grade 4.

Numerous studies have been made of one or more patients at variable intervals after total gastrectomy. Among these are studies by Walters (28), Pack and McNeer, Rekers, Pack, and Rhoads, Lahey (11), Longmire, and Farris, Ransom, and Coller. Pack and McNeer found in controlled studies that there was an excess of fecal fat and nitrogen after total gastrectomy, indicative of subnormal utilization of these products when the stomach was absent. Anemia has been noted by many observers after total gastrectomy. Balfour, Higgins, and Woods, working with rats, noted, after gastrectomy, a deficiency which resulted in anemia and progressive loss of weight of the animals; this could be prevented by ingestion of neutralized gastric juice of men.

In the present study, which includes 13 patients who survived total gastrectomy for 5 years or longer, it was found that approximately half of the group (6 patients) were able to work without difficulty; approximately a quarter of the group (3 patients) could work only part time and an equal number were unable to work at all. Inability to work full time arose from easy fatigability and "dumping" symptoms (1 case) and esophagojejunal stricture (1 case) which the patient refused to have dilated. One patient had retired. While this is a small group of patients, the fact that only half of them were able to work is worthy of note. Somewhat to our surprise it was found that approximately two thirds (69.2 per cent) of the 13 patients regained their preoperative weight. The remainder were unable to gain or maintain satisfactory weight. This inability coincided with the postoperative appetite of the patients; 9 had good appetites and 4 did not. Undoubtedly the postoperative caloric intake is of great importance in the patient's general well-being and ability to work. Diarrhea or other abnormality of bowel habit was only an infrequent difficulty.

None of the 13 patients could maintain a satisfactory concentration of hemoglobin without the use of iron or some other form of treatment. No case of anemia, however, was diagnosed as addisonian in type. If adequate treatment was continued, the anemia usually could be controlled in a relatively satisfactory manner.

COMMENT

The type of technical procedure that is carried out, provided it is well chosen and properly executed, seems to make little difference in the operative mortality associated with total gastrectomy. Thus, the risk involved in performing esophagoduodenostomy, in properly selected cases, is no greater than that associated with esophagojejunostomy. Likewise, establishment of anastomosis between ascending and descending loops of jejunum seems to exert no significant influence on sur-

gical mortality. The same is true for use of the indwelling jejunal tube during the early postoperative period. For the past several years it has been our practice to use neither entero-anastomosis nor an indwelling nasal catheter, although formerly both of these were employed.

We believe that in past years there has been more postoperative delay than is necessary or advisable in starting to give nourishment normally by mouth. We start giving nourishment by mouth within 48 hours after operation, assuming that the patient's condition has not been unusual in the early postoperative course. It seems likely that in past years we have increased the diet too slowly after operation and have unnecessarily postponed the time when the patient is permitted at least a maintenance caloric intake by mouth. Those who favor postoperative nasal intubation point out, among other things, that the method allows early administration of nourishment. This is true but if the patient is able to take nourishment by mouth, there is no need to give it to him through a tube. Use of the indwelling nasal catheter is attended, of course, with certain undesirable features, in addition to the discomfort which it causes the patient.

An unanswered question at present is whether total gastrectomy should be the routine surgical procedure in all operable cases of gastric carcinoma. Numerous considerations come to mind relative to this question. We think there would be rather general agreement that if such a plan is followed, at least at present, only highly experienced surgeons should follow it. Otherwise, an excessive operative mortality would be likely to be incurred for only a questionable improvement in late results.

The essence of any successful operation for carcinoma is complete removal of all malignant tissue and preservation of the patient in a condition which makes him glad to be alive. Obviously, in the presence of gastric carcinoma, there are numerous regions, besides a remnant of the stomach, where carcinoma may be residual. We wonder if perhaps too much emphasis has been given to complete removal of the stomach and too little emphasis to complete removal of the other tissues. Any operation for neoplasm which stands the test of time must necessarily be based on an accurate conception of the lines of spread of the malignant growth. These do not go just in one direction, such as along the wall of the stomach, but in numerous other directions, extragastric in location, primarily along communicating lymphatic channels; the growth also may spread by direct extension. Individual variations occur and all gastric surgeons have seen a large carcinoma which had remained localized in the stomach and, so far as the pathologist could tell, had not spread to the regional lymphatic structures. The operating surgeon cannot be certain of the extent of extragastric spread, however, and must follow a pattern of resection which includes all possible routes of spread. This requires wide resection of the regional lymph nodes along both curvatures of the stomach, the infraduodenal and supraduodenal nodes, the gastrocolic omentum, the greater omentum, the gastrohepatic omentum, nodes at the origin of the left gastric artery, the hilus of the spleen, often the spleen itself, and at times, the tail of the pancreas. Tissue susceptible of being concerned in direct extension must also be widely resected. Perhaps, as was mentioned previously, more emphasis should be given to the importance of removing these tissues than to complete excision of the stomach itself. In our opinion, these structures can be removed with as close an approach to completeness if a small amount of stomach is permitted to remain as when total gastrectomy is performed.

Locally, all of the gastric tissue that is involved by the growth must be removed, but the value of removing a considerable amount of uninvolved gastric tissue seems open to question. Although, on gross examination, the exact amount of extension of a neoplasm into the adjoining gastric wall cannot be determined, routine histologic study of multiple sections of the resected edges of the stomach provides fairly accurate information in this regard. If such a study is made, the chance of leaving residual carcinoma in the gastric remnant is greatly reduced. Such a procedure is equally important if total gastrectomy is performed, as extension of gastric carcinoma

into the esophagus or duodenum is not uncommon. Obviously, total gastrectomy may be inadequate if a portion of the esophagus and duodenum is not removed, just as subtotal gastrectomy may be inadequate if resection is not carried out well beyond all direct extension of the growth.

In a recent report (18) evidence is presented that recurrent carcinoma was found in the gastric remnant of 50 per cent of 92 persons who survived partial removal of the stomach for carcinoma but who later came to necropsy. It is difficult to infer from these findings that total gastrectomy should be performed in all cases when the "adequacy" of the original partial gastrectomy is unknown. In other words, how far beyond the growth was the line of resection placed and was the cut edge examined histologically for carcinoma? The amount of stomach removed is less important than whether the segment removed contains all of the carcinoma. As in the detection of carcinoma elsewhere, histologic study is of great help in this regard.

As was mentioned previously, further time must elapse before accurate evaluation of routine total gastrectomy for all cases of gastric carcinoma will be possible. Carefully controlled series of a significant number of cases, in one of which subtotal gastrectomy, and in the other of which total gastrectomy, has been performed for similar lesions, seem essential for this evaluation. Moreover, it will be necessary to follow the patients for a minimum of 5 years after operation. In the meantime, we think the evidence is inadequate to justify advising total gastrectomy in all cases of gastric carcinoma. For example, would you, the reader, like to have total gastrectomy performed if you had a small, prepyloric carcinoma?

SUMMARY

One hundred and eighty-five cases in which total gastrectomy was performed have been reviewed. A malignant lesion was present in 170 cases and in the remaining 15 cases the lesion was benign. Technical considerations such as the type of anastomosis, the establishment of jejunojejunostomy, and the postoperative use of an indwelling nasal catheter had little effect on the surgical risk so long as a well chosen and carefully executed operative procedure was performed.

Six patients, each of whom was subjected to total gastrectomy for a benign lesion, were followed 5 years after operation. Four of these were alive. Fifty patients who had total gastrectomy performed for a malignant lesion of the stomach were followed for 5 years. Nine (18 per cent) of these were alive. Half of the patients who survived total gastrectomy for 5 years were able to perform their usual work. Half of the remaining patients were able to work part time. All required treatment for anemia. Approximately two thirds of the patients who survived 5 years regained their preoperative weight.

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LIGATION OF THE INFERIOR MESENTERIC ARTERY AT THE AORTA IN RESECTIONS FOR CARCINOMA OF THE SIGMOID AND RECTUM

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CARCINOMA of the colon and rectum spreads very largely by way of the lymphatics. The other two routes of spread, by direct extension and by the blood stream, are not included in this discussion. As the lymphatics follow closely the arterial supply to the bowel, the higher the artery to a segment of involved bowel is ligated at operation the more lymph nodes it is possible to remove. In resection of carcinomas of the right and transverse colon, high ligation of the ileocolic and middle colic arteries and their accompanying lymphatics is generally practiced. In carcinomas of the sigmoid and rectum, however, such is not the case. High ligation here has not had the consideration it deserves. This is the area, moreover, in which about 75 per cent of large bowel cancers occur.

The importance of the lymphatic routes of spread in these tumors is shown by the incidence of node metastasis in 337 cleared specimens of carcinomas of the descending and sigmoid colon and rectum removed at operation (Table I). By the time the patient is operated on, the tumor has reached the lymph nodes in about one half of the cases.

The need for higher ligation to forestall the spread of the tumor in the lymphatics is indicated by the frequency of metastases in the most proximal lymph nodes in the mesentery of specimens removed at operation. These are the tumors which Dukes classifies as C_2 (Table II). In 326 tumors of the left colon and rectum there were 39 of this type, an incidence of 12 per cent. In 24 tumors of the descending colon it was 21 per cent, suggesting a special need for higher ligation in this group. The accompanying drawings (Figs. 1 through 4) show examples of these C_2 tumors removed at operation. All specimens were cleared of fat by a modification of the Spalteholtz technique. Each lymph node was then dissected out under transillumination, sectioned, and its position charted on a drawing to show its position in relation to the tumor and the main blood vessels. The 109 tumors of the descending and sigmoid colon were all simple segmental resections with excision of only the branches of the inferior mesenteric artery. The 74 tumors of the rectosigmoid were anterior resections in that removal of varying portions of the inferior mesenteric artery was done in all, but mobilization of the upper rectum was not carried out in some of the higher tumors. In 4 tumors anterior excision and colostomy (Hartmann) was done. Most of these lesions lay in the rectosigmoid and lower sigmoid but some were in the mid and upper sigmoid and one was in the descending colon. Of the 143 rectal lesions, 136 were removed by abdominoperineal resection and 7 by abdominoanal pull-through resection as described by Hiatt. Eleven specimens removed by perineal proctectomy were not included as the high occurrence of C_2 cases in this group is well known and the operation is now rarely used.

The lymphatics of the left colon follow closely the inferior mesenteric artery and its branches. In the rectum the lymphatics follow the 3 arteries supplying this area, the inferior mesenteric or superior hemorrhoidal, the middle hemorrhoidal, and the inferior hemorrhoidal, but the upward route along the inferior mesenteric artery is by far the most important and is the main route of spread for carcinomas of the rectum and sigmoid. The artery shows considerable variation in its

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branches. An excellent study of it has been carried out by Goligher based on observations made during anterior and abdominoperineal resections on 36 patients and on dissections of 75 cadavers. Figure 5A, B, C, redrawn from Goligher (11), show the three commonest arrangements of the artery. The first was present in 40 of 75 cadavers, or 53 per cent, and shows the left colic and the first sigmoid arteries arising conjointly from the inferior mesenteric 1½ inches from its origin. The second, occurring in 40 per cent, shows the first sigmoid arising ½ to ¾ of an inch distal to the left colic, and the third, occurring in 7 per cent, shows the first sigmoid arising from the left colic branch itself.

The level at which the inferior mesenteric artery has been ligated in operations for carcinoma of the rectum and sigmoid has varied greatly. Up to 10 years ago perineal proctectomy was an operation frequently done for carcinoma of the lower rectum, especially in poor risk patients. The artery was ligated just above the peritoneal reflection. This operation has since been generally discarded because lymph node removal was obviously inadequate. In abdominoperineal resection the level of ligation is higher but depends largely on the surgeon. Sometimes it is done at the promontory of the sacrum, sometimes where the artery crosses the left common iliac artery, and sometimes higher. In his original article in 1908 Miles emphasized the importance of high ligations of the artery and recommended doing it just below the origin of the first sigmoid branch. Recently, Morgan and Lloyd-Davies and others have re-emphasized this point. In anterior resection for tumors of the rectosigmoid and sigmoid, whether the upper rectum is mobilized or not, the level of ligation is also variable. It is probably done at a lower level in most cases than in abdominoperineal resection. As early as 1908, 44 years ago, Moynihan advised high ligation in resections for carcinoma of the upper rectum and sigmoid with anastomosis of the descending colon to the lower limb of bowel in the pelvis. He recommended routine removal of the lymph gland which he believed to be always present at the origin of the inferior mesenteric artery from the aorta. In 2 cases he was unable to remove it without ligating the artery at its origin. He believed the blood supply from the middle colic artery to be entirely adequate well down into the sigmoid. He advocated ligation of the inferior mesenteric artery either above or just below the left colic artery in all carcinomas of the sigmoid and rectum. In fact, the steps in his technique are very similar to those we have been using for over 2 years and which are described later. Apparently his recommendations at that time received little consideration. In 1941, Dunphy (8, 9) and more recently, McKittrick, have advocated extending the scope of anterior resection to tumors of the lower sigmoid. In 1950 we (12) suggested extending the operation still further to tumors of the mid and upper sigmoid and descending colon. Whether the operation be an abdominoperineal or anterior resection it is obvious that the best level from the point of view of lymph node removal would be the highest possible one, which would be at the origin of the artery from the aorta above its left colic branch. In 1949 we began using this procedure and in 1950 suggested its use (12) in both abdominoperineal resections for carcinoma of the rectum and in anterior resections for lesions of the rectosigmoid, sigmoid, and descending colon. Gilchrist recommended it in abdominoperineal resections if the high nodes in the mesentery appear enlarged or suspicious or are found involved on frozen section. However, it is well known that the size of a node is not an accurate guide as to the presence or absence of metastases. Recently Ault, Castro, and Smith also recommended high ligation in anterior and abdominoperineal resections and care-

TABLE I.—INCIDENCE OF NODE METASTASES (CLEARED SPECIMENS)

Site	No. of specimens	No. of specimens with node metastases	Per cent with metastases
Descending	24	12	50
Sigmoid	85	30	35
Sigmoid and rectosigmoid (anterior resection)	74	33	45
Rectum and rectosigmoid (abdominoperineal)	154	86	56
Total	337	161	48

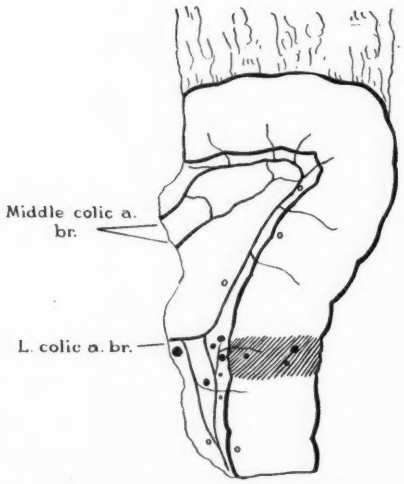

Fig. 1. S.P. 76369. A carcinoma of the descending colon with involvement of the most proximal nodes along the left colic artery.

fully measured the distance of the ligation from the origin of the artery. They reported 5 cases in which ligation at the aorta was done. Two were abdominoperineal resections and 3 were anterior resections. Recently State has reported ligation of the artery at the aorta as an essential part of the abdominoperineal operation which he has used since 1945. He also removes the nodes along the aorta, the inferior vena cava, and common iliac vessels. On behalf of more extensive proximal dissections, he cites Wangensteen and Lewis who have been doing "second look" operations on patients with carcinoma of the rectum. They have found focal metastases along the aorta at the second or third operation in approximately 60 per cent of patients who had lymph

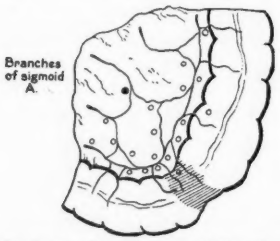

Fig. 2. S.P. A-16. A carcinoma of the sigmoid with a single metastasis in the highest node along one of the sigmoid arteries.

node metastases at the first operation. These foci might have been removed if the first operation had been more extensive. Deddish has reported 25 patients with advanced carcinoma of the rectum in which abdominoperineal resection was done with ligation at the aorta or just below the left colic artery together with radical removal of the pelvic viscera and dissection of the aortic, iliac, hypogastric and obturator nodes. Abel also advises high ligation of the artery at the aorta in all advanced cases of carcinoma of the rectum and perhaps in all cases. Goligher has shown that the average distance from the origin of the artery to the promontory of the sacrum is 2½ inches or 10 centimeters and that it is 1½ inches or about 4 centimeters to the bifurcation of the aorta or the origin of the left colic artery. A great many nodes can lie in this short space. In fact, we have found as many as 10 lymph nodes between the origin of the artery and its left colic branch. Removal of these nodes should have an appreciable effect on the survival rate.

Ligation of the inferior mesenteric artery at its origin necessitates dependence on the left branch of the middle colic artery for the blood supply to the upper limb of bowel used for the colostomy or for the anastomosis. When the upper end of the resection is in the descending or upper sigmoid colon and when an anastomosis is to be done, special care must be taken to ligate the left colic artery medial to its arcade so that the marginal artery in the mesentery is preserved. In the past, the question of blood supply has interested many anatomists and surgeons such as Sudek, Archibald, Jamieson and Dobson, Rubesch, Drummond (5, 6), and Stewart and Rankin. Their observations and their injection experiments suggest that the left branch of the middle colic artery can be depended on for an adequate blood supply well down into the sigmoid colon. Stewart and Rankin found no failure in the anastomosis between the middle and left colic arteries in over 100 injected specimens. However, as they and Jamieson and Dobson pointed out, their findings may not necessarily hold true in old patients with arterial disease. Toupet (23, 24) has recently advocated ligation of the inferior mesenteric

artery at the aorta in conjunction with his modification of the pull-through operation for carcinomas of the sigmoid and carcinomas of the rectum lying more than 10 centimeters from the anal canal. He reports its use in 30 patients. He points out that the blood supply of the transverse colon, the splenic flexure, and descending colon by way of the middle colic artery is more reliable than that of the sigmoid through the inferior mesenteric artery and its branches and that by mobilizing the transverse colon and the splenic flexure completely the latter can be brought down successfully to the anal canal. Thus, the higher the level of bowel resection, the nearer it is to the origin of the middle colic artery and the better its blood supply. This is an important principle to remember in any operation involving ligation of the inferior mesenteric artery at the aorta.

As other writers have emphasized, it is important to free the splenic flexure and the transverse colon in order to obtain adequate length of bowel for a colostomy or for anastomosis. The abdominal incision, which is usually left paramedian or left oblique, should therefore be carried somewhat higher. The descending colon is first mobilized completely. The splenic flexure is then freed. This is usually made easier by first separating the distal half or more of the transverse colon from the omentum and then dissecting the flexure free while exerting traction on both limbs of the flexure at the same time. If the transverse colon is adequately mobilized and the mesentery of the descending colon freed medially to the aorta, the length of bowel that can be brought down is limited only by the length of the middle colic vessels themselves. By reflecting the mesentery of the descending colon to the aorta, the ligation of the inferior mesenteric artery at its origin and of the inferior mesenteric vein just lateral to it at the lower margin of the pancreas is made easier. The origin of the artery is sometimes found under the lower margin of the transverse duodenum. The left ureter must be identified and avoided. The ligated vessels and the accompanying node-bearing tissue are then stripped off the aorta and the inferior vena cava from the duodenum downward.

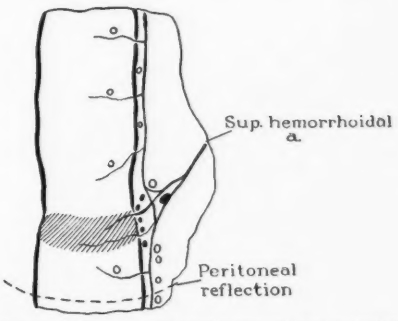

Fig. 3. S.P. 79912. A carcinoma of the rectosigmoid removed by anterior resection with a metastasis in the highest node along the superior hemorrhoidal vessels.

Freeing of the duodenal jejunal angle usually helps the dissection. As already mentioned, if the upper limb is formed by the descending colon and an anastomosis is to be done, the left colic artery is ligated medial to its arcade to preserve the marginal vessels. The exact limits of viability of the bowel must, of course, be determined at operation by evidence of bleeding from the bowel wall, arterial pulsation, and the color of the bowel itself. A possible objection to the procedure is the slightly longer incision and the somewhat increased operative time entailed. Occasionally this may contraindicate the procedure in a poor

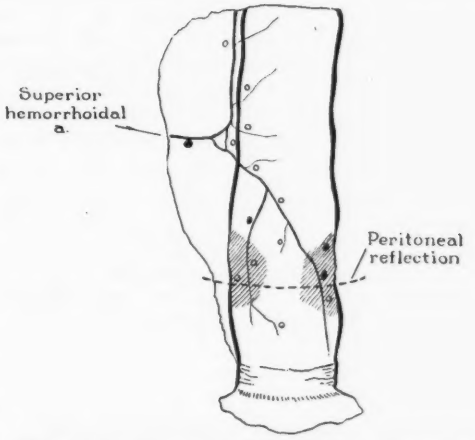

Fig. 4. S.P. 77292. A carcinoma of the rectum with a metastasis in the highest node near the point of ligation of the superior hemorrhoidal artery.

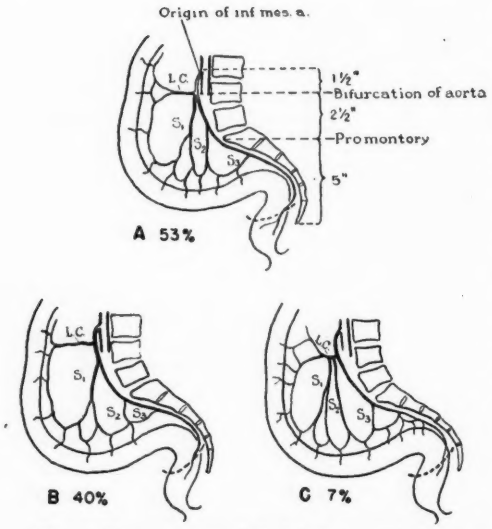

Fig. 5. The 3 patterns of the inferior mesenteric artery and the levels at which its branches most frequently arise. Redrawn from Goligher, courtesy of, *Brit. J. Surg.* (11).

risk patient. The presence of fat in the mesentery may also make it more difficult to identify the vessels. The advantages of the procedure would, however, seem to outweigh the disadvantages by far.

In abdominoperineal resection for carcinoma of the rectum, high ligation at the origin of the inferior mesenteric artery can be done with less difficulty as there is no anastomosis involved. The splenic flexure and distal transverse colon are freed as usual. The colostomy is usually made in the descending colon but may be placed anywhere from the distal transverse colon to the upper sigmoid. It is brought out usually through a separate incision in the left lower quadrant of the abdomen. If at any time the viability of the colostomy appears doubtful, it can easily be freed more proximally and can even be brought out more directly through a higher incision. The amount of bowel and mesentery usually removed is shown in Figure 6.

TABLE II.—INCIDENCE OF PROXIMAL NODE METASTASES—DUKES C_2 (CLEARED SPECIMENS)

Site	No. of specimens	No. with proximal node metastases	Per cent with metastases
Descending	24	5	21
Sigmoid	85	12	14
Sigmoid and rectosigmoid (anterior resection)	74	6	8
Rectum and rectosigmoid* (abdominoperineal)	143	16	11
Total	326	39	12

*11 specimens removed by perineal proctectomy were not included.

In anterior resection for carcinoma of the rectosigmoid and lower sigmoid a longer upper limb of bowel is needed for the anastomosis. As already mentioned, this can be obtained by freeing the splenic flexure and the transverse colon more completely and by preserving the arcade of the left colic artery and the marginal vessels. Here again the end of the upper limb of the anastomosis may be made anywhere from the distal transverse to the upper sigmoid colon. Greater length for the lower limb of the anastomosis can be gained by mobilizing the rectum posteriorly and laterally, with or without division of the middle hemorrhoidal vessels. The line of excision is indicated in Figure 6. A margin of at least 5 centimeters of bowel distal to the tumor and more if possible should be resected to remove any retrograde downward spread in the lymphatics of the bowel wall or its mesentery. Dunphy has recently emphasized the difference between the margin noted by the surgeon while making traction on the bowel at operation, and that in the formalin fixed specimen which may be one-third as great. He advocates an operative margin of 10 centimeters. We are now studying the extent of downward spread in the bowel wall by serial sections of resected specimens.

In resection for carcinomas of the mid and upper sigmoid the same procedure can be used. Simple wedge resection of the sigmoid with removal of only the branches of the inferior mesenteric artery is not radical enough and should be discarded as a routine procedure. It should be reserved only for the occasional very poor risk patient. An adequate cancer operation requires the removal of the main vessel with its accompanying glands and with ligation at as high a level as possible. The area to be excised is shown in Figure 6. The same procedure may be feasible for carcinomas of the descending colon. In fact, the high in-

cidence of proximal node metastasis in these tumors as shown in Table II suggests the need for higher node removal. In these higher tumors of the sigmoid and descending colon it may not be necessary to free the upper rectum. The length of the lower limb for the anastomosis will depend on its viability as evidenced by actual bleeding. In all these resections, however, the proximal end of the lower limb will be in the distal sigmoid. The level of the upper end of the resected bowel will, of course, vary considerably according to the amount of transverse colon and splenic flexure that can be mobilized, the site of the tumor, and the blood supply of the bowel.

In the last 2 years 41 resections for carcinoma with ligation of the inferior mesenteric artery at the aorta have been done (Table III). These cases represent an average group and were not selected because of advanced disease. In a few instances ligation at the aorta was not attempted because of the poor condition of the patient. Sixteen of the 41 tumors were in the rectum or rectosigmoid and were removed by abdominoperineal resection. The colostomy was usually made in the descending or upper sigmoid colon and was brought out through a separate incision in the left lower quadrant. Eighteen tumors were removed by resection and anastomosis. Of these, 3 were in the descending colon, 3 were in the upper sigmoid, 5 in the mid sigmoid, 4 in the lower sigmoid, and 3 were in the rectosigmoid. The anastomosis was done by the open technique in all cases with an inner layer of continuous fine chromic catgut and an outer layer of interrupted silk sutures. Some type of operative decompression was carried out in all but 2 cases. In 5 cases preliminary cecostomy was done because of bowel obstruction, and in 9 cases it was done at the time of resection as an added protection for the suture line. Transverse colostomy was performed before resection in 1 case because of extreme bowel distention and suspected perforation, and at the time of resection in 1 case because of doubt as to the adequacy of the anastomosis. Seven tumors were removed by the abdominoanal pull-through technique. Of these, 2 were in the upper sigmoid, 2 in the lower sigmoid, and 3 in the rectosigmoid.

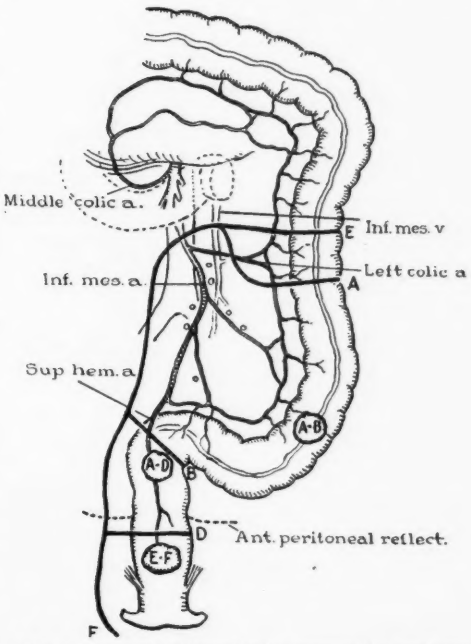

Fig. 6. Segments of bowel to be removed for carcinoma of sigmoid colon *A-B*, lower sigmoid *A-D*, and rectum *E-F*, with ligation of the inferior mesenteric artery at its origin above the left colic artery. The levels of resection at *E* and *A* may range between distal transverse and sigmoid colon depending on the degree of mobilization of the transverse colon and splenic flexure, the site of the tumor, and the blood supply of the bowel.

Thirty-seven of the 41 resected specimens were cleared and the lymph nodes dissected out, sectioned, and charted on drawings. Nineteen of the 41 specimens showed node metastases. In 12 the involved nodes lay relatively close to the tumor, but in 7 there were high metastases which would not have

TABLE III.—LIGATION OF INFERIOR MESENTERIC ARTERY AT AORTA (37 OF 41 SPECIMENS CLEARED)

Type of resection	No. of specimens	No. of specimens with node metastases	No. of specimens with high metastases
Resections and anastomosis	18	6	2
Abdominoperineal	16	8	3
Abdominoanal pull-through	7	5	2
Total	41	19	7

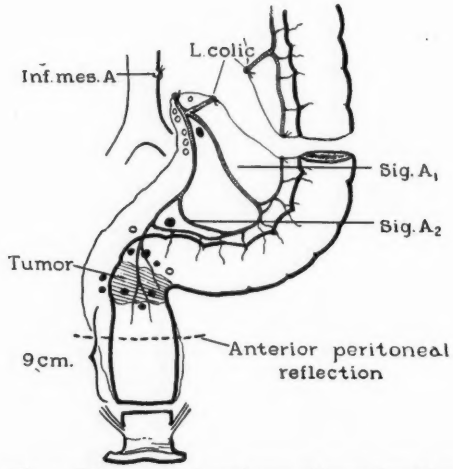

Fig. 7. S.P. A17298. A carcinoma of lower sigmoid removed by abdominoanal pull-through technique with ligation of inferior mesenteric artery at aorta and anastomosis of descending colon to lower rectum. Metastases present in 10 of 44 nodes in cleared specimen, 1 of which lay just below joint origin of left colic and first sigmoid artery.

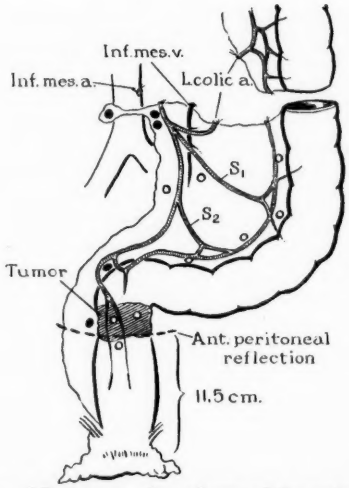

Fig. 9. S.P. A23775. A carcinoma of the rectosigmoid removed by abdominoperineal resection with ligation of the inferior mesenteric artery at the aorta. There were 2 involved nodes above the left colic artery, one of which lay on the right side of the aorta. Another involved node lay opposite the origin of the left colic artery.

been removed if high ligation had not been done. In 2 of the 4 specimens that were not cleared, node metastases were present and in each case the highest lymph node removed separately at the point of ligation of the inferior mesenteric artery from the aorta proved to be involved. This represents an incidence of 17 per cent, or of 37 per cent of those with node metastases.

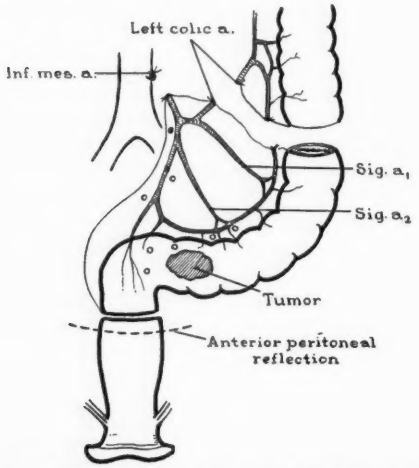

Fig. 8. S.P. A20894. A carcinoma of the lower sigmoid removed by anterior resection with ligation of inferior mesenteric artery at the aorta and anastomosis of descending colon to upper rectum. A single metastasis lay at the origin of the left colic branch.

The 5 cleared specimens with high node metastases are shown in the accompanying drawings. Figure 7 shows a carcinoma of the lower sigmoid removed by the pull-through technique with a node metastasis just below the common origin of the left colic and first sigmoid branch. Nine other nodes were involved. The patient is well 16 months following operation. Figure 8 shows a tumor of the sigmoid removed by anterior resection with a single metastasis opposite the origin of the left colic branch. The patient shows no evidence of recurrent disease 8 months after operation, but unfortunately has an unrelated carcinoma of the prostate for which he is receiving palliative treatment. Figure 9 shows a carcinoma of the rectosigmoid removed by abdominoperineal resection. Five of 25 nodes were involved. Three of the involved nodes lay at or above the level of the left colic artery, one of them lying on the right side of the aorta. The patient is well 2 months fol-

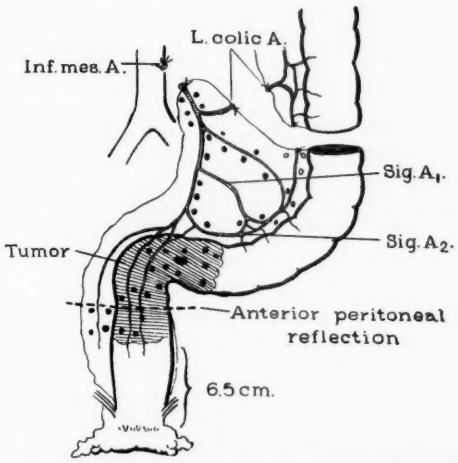

Fig. 10. S.P. A19540. A carcinoma of rectosigmoid removed by abdominoperineal resection with ligation of inferior mesenteric artery at aorta and colostomy in descending colon. Metastases were present in 63 of 67 nodes in cleared specimen. All nodes along the main lymphatic route and alternate arcade of left colic artery and its descending branch were involved, including most proximal at point of ligation of inferior mesenteric artery at aorta. This represents a lateral retrograde spread of 15 centimeters.

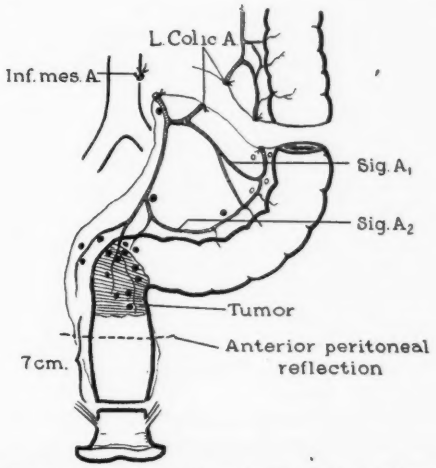

Fig. 11. S.P. A19926. A carcinoma of the rectosigmoid removed by abdominoanal pull-through technique with ligation of inferior mesenteric artery at the aorta and anastomosis of descending colon to lower rectum. Metastases were present in 18 of 45 nodes in cleared specimen. One involved node lay at the point of ligation of inferior mesenteric artery at the aorta and another lay 8 centimeters lateral to the tumor apparently from retrograde spread.

lowing operation. Figure 10 shows a very malignant carcinoma of the rectosigmoid removed by abdominoperineal resection with metastases in 63 of 67 nodes. Four involved nodes lay above the left colic branch. The patient died 8 days after operation of a pulmonary embolus. Autopsy showed metastases in the periaortic nodes and in the lungs. Figure 11 shows a carcinoma of the lower sigmoid removed by the pull-through technique with an involved node above the left colic artery. This patient died of peritonitis following necrosis of the upper limb of the anastomosis. Autopsy showed a single tiny metastasis on the undersurface of the diaphragm. The 2 patients whose specimens were not cleared are alive 8 and 15 months following operation. In both cases the highest node removed separately at the point of ligation of the inferior mesenteric artery at the aorta proved to be involved.

It might be argued perhaps that these high metastatic nodes could have been dissected off the artery and the ligation done at a lower level. Such a procedure, however, would often be difficult and in some cases impossible. It violates a cardinal principle of good cancer surgery and would result in a much less complete removal than is possible when the artery and all the surrounding glands and lymphatics are excised by a single block dissection.

There were 3 deaths in the 41 cases, an operative mortality of 7 per cent. One was from pulmonary embolism, one from sudden auricular or ventricular fibrillation 30 hours after operation, and another from necrosis at the anastomosis and peritonitis. In the first 2 cases the anastomosis was found intact at autopsy. The death from necrosis occurred in the pull-through group. Two other cases in this group had stricture formation following infection in the sacral hollow or necrosis at the anastomosis. We have not as yet determined the value of the pull-through operation when used in conjunction with high ligation of the inferior mesenteric artery at the aorta. The length of bowel needed for the upper limb of the anastomosis to reach down through the anal canal is much greater and its blood supply is much more of a problem. It may be that

this disadvantage can be offset by more adequate freeing of the splenic flexure and the transverse colon. As far as sphincter control is concerned the operation is certainly inferior to anterior resection.

SUMMARY AND CONCLUSIONS

1. A series of 41 resections for carcinoma of the rectum, rectosigmoid, sigmoid, and descending colon with ligation of the inferior mesenteric artery at its origin from the aorta is reported. Sixteen were done by abdominoperineal resection, 18 by abdominal resection and anastomosis, and 7 by abdominoanal pull-through resection. High lymph node metastases were found in 7 of the 41 specimens. There were 3 deaths. The only death from bowel necrosis occurred in the pull-through group.

2. This series of cases is as yet too small for final evaluation. However, the following conclusions on the merits of ligation of the inferior mesenteric artery at the aorta seem warranted: (a) It can be done without significant increase in mortality in anterior resections, in resection and anastomosis operations for carcinoma of the sigmoid and descending colon, and in abdominoperineal resections for carcinoma of the rectum. (b) It permits higher and more complete lymph node removal and should therefore raise the survival rate appreciably. (c) Simple routine wedge resection for carcinoma ot the sigmoid without excision of a portion, at least, of the inferior mesenteric artery and its lymphatics is an inadequate operation and should be discontinued.

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TUMORS OF THE TESTICLE

Irradiation Therapy

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MALIGNANT tumors of the testicle arise from totipatent sex cells. The monodermal forms of these growths represent one sided developments of tridermal teratomas. The tumors are often mixed in type. In case one type predominates, the minor elements may not be found on pathological examination. A seminoma which appears monodermal may contain subversive elements of embryonal carcinoma, chorioepithelioma, or other highly malignant forms. These unrecognized elements not infrequently metastasize independently of the seminoma. The structural patterns may be classified as follows, so far as treatment is concerned: (1) radiosensitive—seminoma; (2) radioresistant —embryonal carcinoma, teratoma, teratocarcinoma chorioepithelioma, and miscellaneous.

Seminoma (germinoma) may be the precursor of embryonal carcinoma, teratocarcinoma and chorioepithelioma and may metastasize as these types (1).

Tumors of the testicle metastasize first and most frequently by the lymphatics but may metastasize by the blood stream. Early metastases by the lymphatics will be unilateral and located in the lumbar lymph nodes situated between the bifurcation of the aorta and the renal pedicle. The disease is curable by radical resection of these glands provided the operative treatment is accomplished before generalized dissemination has occurred. Later in the course of the disease general dissemination to the lungs and other organs takes place by the blood stream and lymphatics.

Early diagnosis is an important factor in the prognosis of malignant tumors of the gonads. In a series of 32 patients at Walter Reed Army Hospital (4) for a 3½ year period ending December 31, 1949, the initial diagnosis of tumor was made in 18 (56 per cent). In the other 14 cases the initial diagnosis was epididymitis, 9; hydrocele, 2; varicocele, 1; no diagnosis was made in 2 cases. The interval of time from onset of symptoms until medical advice was sought ranged from 1 day to 2 years, the average interval for those with metastases was 4.2 months. The average interval from onset to diagnosis was 4.6 months. The average time from diagnosis to operation was 10 days. These data prove that the patient is accountable for the greatest element of neglect and indifference.

Metastasis was present in 14 (44 per cent) patients at the time of peritoneal gland resection. Nine (28 per cent) have died, all of whom had metastases at operation. The hormone test has been of little value in establishing the diagnosis. Early diagnosis and radical treatment are certainly of paramount importance.

Metastases were found in 43 per cent of Lewis' series of 250. Hampton and his associates, in a series of 250 had 42+ per cent radiosensitive seminomas with 19 per cent metastases, and radioresistant tumors, trophocarcinoma, teratocarcinoma, 57+ per cent with 60 per cent metastases on admission. Seminoma in all these series shows the lowest rate of metastases.

The prognosis in patients with testicular neoplasms depends mainly on three factors; namely, (1) structural pattern, especially whether radiosensitive or radioresistant; (2) stage of development of the disease at the beginning of treatment (The prognosis is much graver after metastasis has occurred. Mere time does not determine the stage since some tumors remain local for months while others explode in a few weeks.); (3) the type of treatment (The treatment of choice in all malignant tumors of the testes is early radical operation—orchiectomy and resection of lumbar lymphatics, followed by appropriate irradiation therapy).

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Seminoma gives the best prognosis because it is of low grade malignancy, metastasizes late, and is radiosensitive. Approximately 20 per cent of seminomas showed metastases at the time of operation, whereas such extension was present in 60 per cent.

The treatment of testicular tumors is radical surgery followed by appropriate irradiation. Orchiectomy and resection of retroperitoneal glands should be carried out for all malignant tumors of the testicle. It is advocated by some authorities that seminoma metastases can be cured by irradiation without damage to the normal tissues. Others of equal experience express doubt that deep seated metastases can be cured by such therapy. Be that as it may, it is established that seminoma may metastasize as other types not curable by irradiation, which fact makes radical surgery imperative in an attempt to cure cancer of the testes.

The incision for the gland resection is made from the external inguinal ring to the midaxillary line between the 10th and 11th ribs. It may be continued posteriorly with the risk of entering the thorax; which, however, rarely causes complications.

This incision gives good exposure to the renal pedicle and diaphragm. The radical surgical treatment with irradiation has given better results than simple orchiectomy plus irradiation.

Although seminomas are more radiosensitive than the other types because they may metastasize as a radioresistant type, radiation therapy alone cannot be depended upon to control the tumor spread. Friedman and Moore (2) found 319 patients with seminoma in their series of 922. Metastases were found in 28 of these patients with seminoma. In a later report, Friedman (1) noted that of the 28, the metastasis was embryonal carcinoma, teratocarcinoma, or some other type in 11 patients (39.3 per cent). This kind of radioresistant metastasis makes radical surgical excision of the retroperitoneal lymphatics, testis, and spermatic cord the treatment of choice. The operation is followed by appropriate irradiation.

O'Connell and Geschickter reported the five year survival rate for 216 patients with malignant tumors of the testes treated at the National Naval Medical Center, Bethesda, Maryland. The standardized treatment consisted of ligation of the cord at the internal inguinal ring and excision of its distal portion along with the testis, followed by irradiation.

The comparison of these two reports shows the marked advantage of radical measures (Table I).

Advances in irradiation therapy equipment have been so rapid in recent years that proper evaluation of results even by experts is very difficult. Many powerful and dangerous tools have been discovered and developed. The supervoltage unit, radioactive isotopes, and atomic energy threaten to radically change the treatment of malignant tumors. It is possible that the therapeutic application of these elements will become so effective that the use of the scalpel may soon be obsolete in the management of cancer. The future treatment is unpredictable. Methods and equipment rapidly become outmoded. However, certain basic factors remain steadfast. It is proverbial that the more conditions appear to change, the more they remain the same.

The 1,000 kilovolt radiation unit is in common use and treatment with this type of apparatus has been more or less standardized. At the present time the 2,000 kilovolt supervoltage unit with rotation exposure is considered the safest and most effective type of irradiation.

Tumors of different structural patterns require different intensity of irradiation. The lethal dose for the radiosensitive seminoma is 500 to 1,000 roentgens administered in 2 weeks or 2,000 roentgens over a period of 4 weeks. Rapidity of treatment increases the danger of damage to normal tissue. The radioresistant tumors require larger dosage. Trophocarcinoma and adenoma carcinoma have a lethal dose of 3,500 to 4,000 roentgens in 2 weeks. Chorioepithelioma requires 4,000 to 5,000 roentgens in 2 weeks. Teratocarcinoma may require up to 6,000 roentgens to be effective in 2 weeks.

Any dosage above 4,000 roentgens in a period of less than 4 weeks is hazardous and should be used with caution and only in extreme cases.

Preoperative irradiation is not given at Walter Reed Army Hospital. There are some enthusiastic advocates of this type of therapy as a test dose. They maintain that seminoma may be indistinguishable from radioresistant tumors on histopathological examination or that a test dose, treatment of 1 to 2 weeks, will establish the irradiation response and determine accurately the postoperative dose. They also assert that the destruction of radiosensitive elements make the radioresistant elements available for examination. Some "far to the right" radiologists who do not favor retroperitoneal gland resection claim that rapid shrinkage of the tumor indicates seminoma and makes the radical operation unnecessary. These reasons for preoperative radiation are not valid and are dangerous in that the orignal type of tumor may be so altered as to be unrecognizable and a rapidly reduced tumor may have radioresistant elements remaining to develop deadly metastases. It is not sound therapy to delay operative treatment while experimenting with such a questionable procedure.

Postoperative irradiation is considered under the following headings: (1) curative, (2) prophylactic, and (3) palliative.

Curative: It has been asserted repeatedly that seminoma is curable by irradiation alone; however, there is considerable doubt that such therapy will cure deep seated cancer. The mortality rate is much greater in cases showing metastases at operation than in those without metastases.

Postoperative, prophylactic, and curative irradiation are used in all patients with testicular cancers at Walter Reed Hospital.

Treatment is started 7 to 10 days following operation. It is probable that irradiation does not interfere with wound healing and may be started immediately after operation. However, it is advantageous to begin 7 to 10 days later, in order to evaluate the structure of the tumor and to permit the patient to have a few days postoperative recovery. The lymphatic drainage channels of the involved testicle are given x-ray therapy. The treatment fields extend from the external inguinal ring to the diaphragm anteriorly and posteriorly. Those patients in whom retroperitoneal metastases were found at operation are irradiated from the diaphragm upward through the mediastinum and left supraclavicular areas. The 1,000 kilovolt unit is used. The treatment plan consists of irradiating the anterior and posterior fields in a given area until completed. One field is treated daily with a 400 roentgen skin dose.

TABLE I.—COMPARISON OF SURVIVAL RATES OF SERIES OF PATIENTS

Classification	U.S. Naval Hosp.		Walter Reed Army Hosp.		Difference per cent
	No.	Per cent	No.	Per cent	
Radiosensitive Seminoma	75	59.6	103	81	21.4
Radioresistant Teratocarcinoma embryonal carcinoma	141	19.1	100	37	17.9
Total	216	31.7	203	57	25.3

The total tumor dose to the lymphatics is 2,000 roentgens in 15 days for seminoma and 4,000 roentgens in 25 days for all other types. A tumor dose of 400 roentgens is considered the maximum permissible safe dose in the abdomen using the 1,000 kilovolt therapy. All patients are given irradiation therapy even though the maximum dose of 400 roentgens is not cancerocidal for many of the teratocarcinomas.

Because of the damaging effects of irradiation of more than 4,000 roentgens it has been proposed to dispense with prophylactic treatment in patients requiring more than this dosage who have no metastases demonstrated at operation. This plan has not yet been adopted at Walter Reed because it is highly theoretical and might contribute to the loss of an occasional patient.

Palliative irradiation is used to relieve pain, delay the spread, and prolong life in patients with hopeless metastases of various structures. The dosage is established by observing the tumor reaction and the patient's general condition.

Irradiation sickness occurs in a great number of patients undergoing treatment. This illness is manifested by loss of appetite, nausea, vomiting, lassitude, loss of weight, and leucopenia. This is a serious complication of

the therapy and often makes it necessary to interrupt the irradiation. These complications are combated by reducing the irradiation. Pyridoxine, 100 milligrams is given intramuscularly prior to each x-ray treatment. Multivitamin therapy is carried out throughout the course. The leucopenia is corrected by blood transfusion. This irradiation sickness often becomes a major factor conducting this type of therapy.

There is an individual variation of tolerance to irradiation. A retroperitoneal dose of 4,000 roentgens given in a 30 to 40 day period is generally well tolerated. A few patients tolerate 6,000 roentgens.

The most consistent finding is that of fatigue evidenced by reduced endurance, often necessitating a change of occupation. The majority of patients show evidence of infertility and a high percentage have diminished libido or impotence.

One of the most frequent complications has been disturbance of the gastrointestinal tract. Various degrees of obstruction are encountered in the colon, less marked in the small bowel. The small bowel is more mobile than the colon and is probably not subjected to the constant irradiation as is the fixed colon. The most constant findings are ulceration and perforation, matting and fixing of the intestinal loops, shortening and narrowing of the lumen. These findings often occur 1 to 4 years following treatment.

Kidney damage not infrequently occurs. Renal atrophy, decreased function, and sclerosis have been found in patients who were given more than 4,500 roentgens.

Skin reactions have been common with 200 kilovolt therapy, whereas deeper tissue sclerosis has been more often encountered with 100 kilovolt exposure.

A few patients have been disabled by radiation myelitis, evidenced by paralysis of the lower extremities. Occasionally radiation pneumonitis has been observed.

With proper care and reducing the dosage these complications are at present avoided or reduced to the occasional accidental occurrence.

Radical surgery, followed by controlled irradiation therapy, is the treatment of choice for all malignant disease of the testes.

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THE ELIMINATION OF UNTOWARD RADIATION SEQUELAE IN THE TREATMENT OF CARCINOMA OF THE UTERINE CERVIX

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IN a consideration of the problem of elimination of untoward radiation sequelae in the treatment of carcinoma of the uterine cervix, two important questions arise. These are: (1) How may factitial reactions be avoided? (2) Should such reactions be entirely eliminated? This discussion has been designed to explore only the second of these questions which may be considered the more basic one. Furthermore, elucidation of this primary problem concerning complications as a necessary evil should cast some light upon the question as to how the individual reactions may be circumvented.

As a basis for discussion, we must assume that ionizing radiations are traumatic to all tissues and that their therapeutic effect lies in the differential recovery rate between cancer tissue and the normal supporting structures. There must be a minimal amount of radiation which will destroy or inactivate the tumor and a maximal amount which will prevent the normal tissue of the tumor bed from recovering from injury. If this premise is true and the incidence of both complications and clinical successes can be found to parallel a quantitative expression of the amount of radiation delivered, then the relationship between complications and results can be explored. The solution to the question as to the importance of eliminating untoward reactions should lie in the relationship between complications and outcome.

THE METHOD

The material used in this study includes patients primarily treated for carcinoma of the cervix uteri at the Los Angeles Tumor Institute, between 1945 and 1950, inclusive. From this group, patients classed as League of Nations stage IV were excluded because their uniformly unsuccessful results and their high rate of complications have been found to have little bearing upon the amount or type of treatment employed. The remainder of the group includes 214 patients of the clinical stages I, II, and III. The choice of recently treated patients allowed for a more accurate evaluation of the clinical factors to be studied, even though ultimate end results would be necessarily incomplete. The technique of treatment included external x-rays with the following factors: 500 kilovolts, 5 milliamperes, 1 millimeter lead (equivalent) filter, 50 centimeters skin target distance, 6 millimeters copper half value layer. Usually, 2 anterior and 2 posterior pelvic portals of 150 square centimeters were used, and dosage schedules were 150 roentgens (in air) to 2 portals daily, to a total of 1,800 roentgens (in air) to each. Radium implantations were performed according to several techniques, which included intrauterine tandems, with intravaginal bombs, specially designed intravaginal sponge rubber colpostats, interstitial parametrial needles, and also the Ernst applicator. Usually, 2 radium implantations were applied, about 2 weeks apart, at the completion of the external radiation. Total exposures were in the order of 6,000 milligram hours, with the actual doses expressed at point A in the pelvis in the order of 7,000 gamma roentgens.

The dosage data and clinical information concerning these patients were gathered from their records and transferred to punch cards, from which the various correlations were made. It must be admitted that the application of statistical methods to clinical data for the purpose of analysis may yield misleading conclusions. This is not the fault of the method, for mathematical measurements cannot make up for a lack of accuracy in the basic data, and clinical information is notably difficult to categorize. However, such a method of study

From the Los Angeles Tumor Institute.

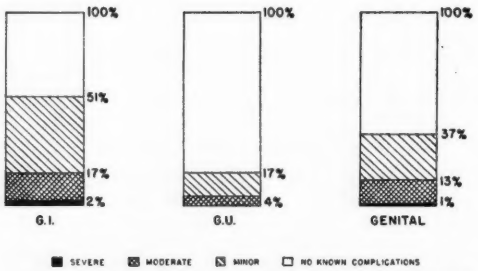

Fig. 1. Incidence of complications attributed to primary radiation treatment of carcinoma of cervix uteri in 214 stages I, II, and III patients from 1945 to 1950, inclusive.

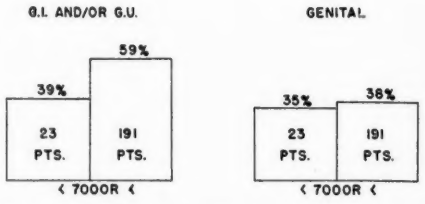

Fig. 2. Incidence of complications in relation to total dose at point A.

can be used to express and emphasize impressions which are the results of clinical experience.

THE RESULTS

The incidence of complications. The incidence of complications attributed to the treatment of the disease is expressed in Figure 1. These reactions are divided geographically into three main types; namely, reactions in the bowel, those referable to the genitourinary system, and those occurring locally in the uterus and parametria (2, 4). They are further divided according to severity. Criteria for these divisions depended upon the degree of disability which the complications caused the patient. For example, diarrhea necessitating medication for the ambulatory patient was considered a minor gastrointestinal reaction. Rectal bleeding which demanded topical treatment was considered moderate, and rectal obstruction which resulted in hospitalization or surgical management was, of course, a major reaction. Of the complications of the internal genitalia, local necrosis was considered minor, parametritis or pyometra was called moderate, and pelvic peritonitis or abscess was classified as a major complication. The urinary complications were similar, with mild cystitis as the minor type, hematuria or telangiectasia of the bladder, a moderate complication, and ureteral fibrosis or fistula, of major severity.

The graphic representation of the percentage incidence of these various undesirable reactions is exclusive in that patients demonstrating more than one complication are shown only in the more severe category. In this series the gastrointestinal complications are the most frequent, and the urinary ones, the least frequent. Minor complications are, of course, of higher incidence than the moderate or major ones. Of the group, diarrhea and local necrosis or telangiectasia appear to be the most common complications.

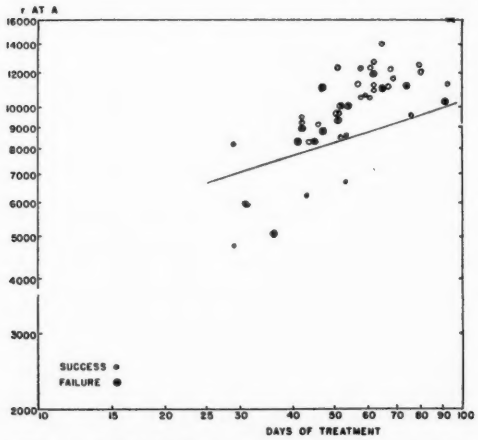

Fig. 3. Graph showing occurrence of all moderate and severe gastrointestinal and genitourinary complications in relation to time and dose for stages I, II, and III.

The incidence of complications in relation to dose. In order to explore the possible dependence of complications upon the amount of treatment, Figure 2 was prepared. The incidence of bowel, bladder, and genital complications is compared in relation to the total dose at point A (3). The dose of 7,000 roentgens has been used to denote a theoretically cancerocidal dose in previous studies. As might be expected, cervical necrosis or uterine inflammations do not appear dependent upon the amount of radiation delivered to this key point in the pelvis. (Actually the incidence of these complications could be correlated with

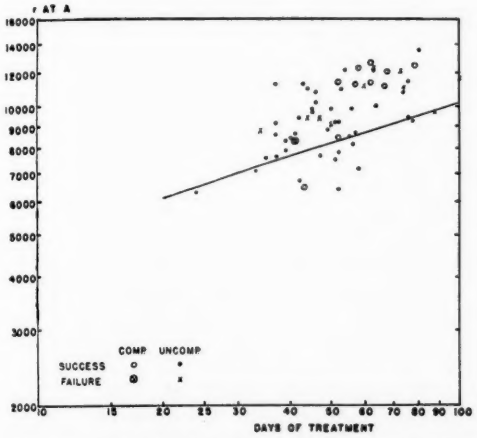

Fig. 4. Graph showing occurrence of complicated and uncomplicated cases and clinical successes and failures according to time-dose relationship in stage I patients.

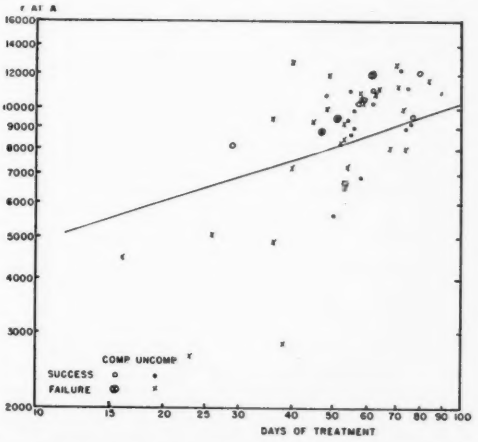

Fig. 5. Graph showing same type of relationship for stage III lesions as is illustrated in Figure 4 for stage I patients.

other factors, such as the type of applicator and the condition of the patient, which should have more bearing on them than the total parametrial dose.) Although the amount of radiation delivered to point A is not an accurate measurement of the actual dose to the rectal or vesical septa, it would be expected to parallel these doses. The incidence of proctitis and cystitis in relation to high or low dosage, as measured in the parametrium, indicates a dependence of this type of reaction upon dosage.

The incidence of successful treatment in relation to complications. Although the criteria for success in this series cannot be complete because of the short term follow-up, the results have been found to follow those reported according to much more rigid criteria for an earlier and larger series. In this present group, successful treatments include patients alive, lost, or dead without disease, and failures are those who are dead, lost, or alive with disease. Since a comparison indicates that there is no direct statistical dependence of success or failure upon the incidence of any of the three groups of complications, there may be other factors more influential in the determination of successful treatment. Previous analyses have indicated that success or failure depends greatly upon the gross extent of the lesion; further, the amount of radiation delivered has been found to be of importance within each of these gross stages. In addition to these factors, a third important point is the time in which the total dose is delivered. An attempt has been made to correlate clinical success or failure with complications by taking into account these three influences.

Figure 3 is a spot graph showing the occurrence of all moderate and severe bowel and

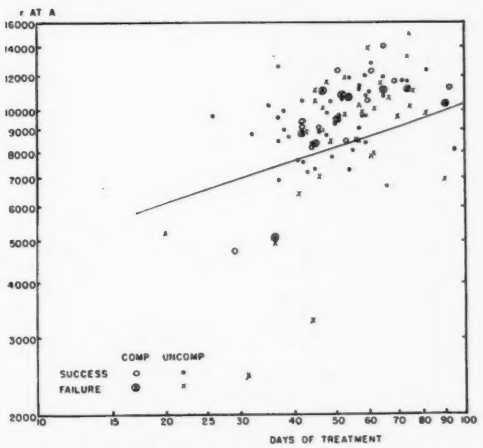

Fig. 6. Graph showing same type of relationship as in Figures 4 and 5 for stage II cases.

urinary complications in relation to time and dose for all three stages of the disease. From these points a line may be drawn, above which 91 per cent of complications occur (5, 6). This "minimal complications line" extends from 7,000 roentgens at 25 days through 9,000 roentgens at 73 days; the slope of the line is that of similar time-dose relationships published by others (1).

Figure 4 is a spot graph showing the occurrence of complicated and uncomplicated cases and clinical successes and failures according to dose-time relationship for the stage I patients in this group. On this log-log scale, a straight line may be drawn, above which the complicated cases appear. The percentage of successfully treated patients lying beneath this line is 92 per cent as compared to 80 per cent for the patients above the line. This would indicate that it is probably not necessary to increase the dose at point A in stage I patients, above that which will cause complications or, in other words, that an optimal dose for stage I lesions probably lies near the dose which will cause complications.

Figure 5 shows the same type of relationship for stage III lesions. In this stage of the disease the tumor has spread beyond point A, presumably, in all patients, and the technical problem of adequately irradiating the outer limits of extension involves the delivery of fairly high doses in the region of point A. With the same minimal complications line drawn as seen in the previous graph, one can see that most of the patients receiving doses beneath this were clinical failures. (The percentage of successful patients being 33 per cent beneath the line as compared to 43 per cent above the line.) In this stage, then, it is probable that the optimal treatment line is higher than the minimal complications line. In other words, with our present techniques, complications must be expected in order to achieve clinical cure.

In the final graph, the same type of distribution is shown for stage II cases. In this stage of disease the lesion has probably extended to point A in most of the cases. However, some patients may have downward vaginal extension away from point A and still be in this group; in these the correlation of reactions with parametrial dose is not quite valid. For example, radium may be placed against a vaginal metastasis and yield complications because of a high rectal dose, and yet contribute little to the parametrial dose. On the other hand, higher dosage to point A alone may not affect the control of such a vaginal extension. In the stage II cases the percentage of successful patients above the complications line (58 per cent) is about the same as that beneath it (52 per cent).

SUMMARY

We have attempted to analyze from our own experience the clinical occurrence of factitial radiation reactions. The complications that depend upon the amount of radiation delivered are selected and their incidence compared to the incidence of successful treatments, which has been found to depend upon the stage of disease and the dose delivered in relation to the treatment time. The comparison has been used to answer the question as to whether these complications should be accepted as a necessary sequel to successful treatment. The answer to the question must be stated as yes and no—"yes" in the case of advanced lesions and "no" in the case of early ones. These findings suggest that some complications may be decreased by improvements in treatment techniques which will allow for more adequate distribution of radiation to the lateral extensions of the tumor without intensifying the dose to the paracervical regions.

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THE TREATMENT OF ANEURYSMS WITH FIBROBLASTIC AGENTS

Experimental and Clinical Studies with the Use of Sodium Dicetyl Phosphate

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IN a previous article (1) one of us (J.K.B.) described the fibroblastic effects of various compounds in experimental animals. We found that a 0.9 per cent solution of dicetyl phosphate in olive oil produced an enormous amount of fibroplasia without necrosis or toxic effects and was therefore useful in the experimental production of portal cirrhoses of the liver when injected into the portal vein (2), coronary occlusion when instilled in the coronary vessels, and perivascular fibroplasia when injected in the adventitia of blood vessels. Following the publication of our results we received many requests for more information concerning the chemical nature of the substance used, the technique of its employment, and the results obtained by its use in man. This report will describe experimental studies with sodium dicetyl phosphate and its use in patients with aneurysms of arteriosclerotic and syphilitic origin.

CHEMICAL NATURE OF DICETYL PHOSPHATE

The following description of the preparation of dicetyl phosphate was furnished by the manufacturer:

"

$$3C_{16}H_{33}OH + P_2O_5 \rightarrow (C_{16}H_{33}O)_2P\text{-}OH + C_{16}H_{33}O\text{-}P(OH)_2$$

In a dry 5 liter four-necked flask equipped with a stirrer, dropping funnel, and thermometer, and closed with a calcium chloride drying tube, 213 grams (1.5 moles) of phosphorus pentoxide is suspended in 1,500 milliliters of dry benzene. Over a period of about 3 hours a solution of 1,094 grams (4.5 moles) of cetyl alcohol in 2,000 milliliters of dry benzene is added dropwise at room temperature. During the addition the temperature rises to about 40 degrees and the reaction mixture becomes a homogenous pale brown solution. After stirring at room temperature for 3 hours the solvent benzene is stripped under reduced pressure (water pump) until the temperature of the product reaches 100 degrees. The residual brown oil, which solidifies to a tan wax-like solid on cooling, may be conveniently divided into 5 approximately equal portions in tared 2,000 milliliter Erlenmeyer flasks. The crude product is then recrystallized with Nuchar C treatment using 455 milliliters of ethanol and 45 milliliters of acetone for every 85 grams of crude material in order to separate the monocetylphosphate from the dicetyl phosphate. The resulting off-white dicetylphosphate may be further purified by two recrystallizations in the regular manner from ethanol to yield about 400 grams of analytically pure dicetylphosphate, melting point 72 to 72.5 degrees, as white, pearly leaflets."

Sodium dicetyl phosphate is a tribasic salt with two hydrophilic radicles; namely, sodium and phosphate. The dicetyl component remains as a suspension which is easily injectible and does not require heating. Moreover, the strength of the solution may be greatly increased over that which is employed in olive oil.

EXPERIMENTAL DATA

Toxicity of aqueous solutions and effects on tissue cells in small animals. Four white rats were used and aqueous solutions of sodium dicetyl phosphate were injected in the adventitia of the abdominal aorta in the following strengths:

Rat No. 1—weight 280 grams, 0.2 cubic centimeter of a 10 per cent aqueous solution of sodium dicetyl phosphate.

Rat No. 2—weight 280 grams, 0.2 cubic centimeter of a 1 per cent aqueous solution of sodium dicetyl phosphate.

Rat No. 3—weight 290 grams, 0.2 cubic centimeter of a 0.5 per cent solution of sodium dicetyl phosphate.

Rat No. 4—weight 250 grams, 0.2 cubic centimeter of a .25 per cent solution of sodium dicetyl phosphate.

From the Departments of Surgery, Indianapolis General Hospital and the Indiana University Medical Center. This study was supported by a grant from the Chas. J. Wolf Foundation for Medical Research.

All animals made a satisfactory recovery and were sacrificed at the end of 4 weeks. There was no apparent dilatation above the site of injection or constriction below. The entire aorta and vena cava above and below were removed and paraffin sections were made for microscopic examination. A study of these sections showed the greatest amount of granulation tissue in Rat No. 2 with active inflammation and well advanced fibroplasia. Undoubtedly more fibrosis would have occurred if more time had been allowed. The reaction was that usually seen in response to a low grade tissue irritant (Fig. 1).

These experiments indicated that solutions up to 10 per cent are safe, producing practically no destruction of tissue cells, and inducing fibroplasia slowly in 4 weeks. Experiments were continued on dogs so that gross as well as microscopic changes could be observed more readily.

Effects of various strength solutions of sodium dicetyl phosphate in dogs. B-104, a healthy mongrel dog was anesthetized with 345 milligrams of sodium pentobarbital given intraperitoneally. The femoral arteries were exposed and 0.5 cubic centimeter of a 2 per cent aqueous solution of sodium dicetyl phosphate was injected in the adventitia around the right femoral artery and a 1 per cent solution around the left. Next, both common carotid arteries were exposed and ½ cubic centimeter of a 0.5 per cent aqueous solution of sodium dicetyl phosphate was injected around the right and a .25 per cent solution around the left. Incisions were closed with silk sutures and the dogs recovered very rapidly. Four weeks later the sites of injections were inspected. The left common carotid had almost as much fibroblastic proliferation with the 0.5 per cent as did the right femoral artery with a 2 per cent solution. The reaction consisted of a bulbous enlargement of the artery at the injected area which was indurated and firm. However, pulsations could still be felt. The microscopic sections showed a foreign body reaction with fibroplasia and a minimal amount of necrosis.

Comparative results with aqueous and olive oil solutions. B-95, a healthy mongrel dog was anesthetized with 372 milligrams of pentobarbital sodium given intraperitoneally. The inner aspect of both thighs and both sides of the neck were surgically prepared in routine manner. The femoral arteries were injected with 0.5 cubic centimeter of a 2 per cent aqueous solution of sodium dicetyl phosphate. Both carotid arteries were exposed and the right was injected with 1 cubic centimeter of a 2 per cent aqueous solution of sodium dicetyl phosphate and the left with 1 cubic centimeter of a 0.9 per cent solution of dicetyl phosphate suspended in olive oil. The incisions were closed with silk sutures and the animal made an uneventful recovery. Six weeks later sections of the vessels were removed for microscopic study. The fibroblastic reaction to the 2 per cent aqueous solution of sodium dicetyl phosphate was greater than that induced by the 0.9 per cent solution of dicetyl phosphate in olive oil. However, all vessels showed an enormous amount of fibroplasia (Fig. 2).

Periarterial injection of the abdominal aorta. B-99, a healthy mongrel dog was anesthetized with intraperitoneal sodium pentobarbital. A segment of the abdominal aorta was dissected free below the level of the renal arteries and 7 cubic centimeters of a 2 per cent aqueous solution of sodium dicetyl phosphate were injected in the adventitia of the anterior portion of the aorta. Four weeks later the dog was re-explored and the abdominal aorta was inspected and a segment removed. A prodiguous amount of fibroplasia is apparent on gross and microscopic examination, as shown in Figure 3.

Periarterial injection of the thoracic aorta. B-104, a healthy mongrel dog was anesthetized with pentobarbital sodium given intraperitoneally. Through an incision in the left fifth interspace 10 cubic centimeters of a 2 per cent aqueous solution of sodium dicetyl phosphate were injected in the adventitia of the thoracic aorta. Seven weeks later, this segment of vessel was excised and the aorta approximated by a continuous eversion stitch of No. 00000 silk, reinforced with an over-and-over suture of the same material. The animal recovered without complications. A great amount of thickening was apparent in the excised segment and microscopic sections showed this to be fibroplasia with practically no necrosis (Fig. 4).

These experiments indicate that a 2 per cent aqueous solution of sodium dicetyl phosphate may be injected periarterially without untoward or toxic effects and with resultant fibroplasia. The reaction is equal to that of a 0.9 per cent solution of dicetyl phosphate suspended in olive oil as described in our preliminary report (1), and is easier to prepare and inject.

THE USE OF SODIUM DICETYL PHOSPHATE IN THE TREATMENT OF ANEURYSMS OF ARTERIOSCLEROTIC AND SYPHILITIC ORIGIN IN MAN

A 2 per cent aqueous solution of sodium dicetyl phosphate was prepared and autoclaved at 240 degrees with 15 pounds pressure for 20 minutes. The injections were made through a 21 gauge needle. Various length needles were employed and the curve in the lumbar puncture needle was fashioned to follow the curve of the aneurysm. Since this varies greatly in size, these needles were bent with various degrees of curvature.

Fig. 1. Photomicrograph ×17 (hematoxylin and eosin stain) aorta of rat No. 2 injected 4 weeks previously with .2 cubic centimeter of 1 per cent aqueous solution of sodium dicetyl phosphate. Note the well advanced fibroplasia and its controlled extension on the anterior surface only.

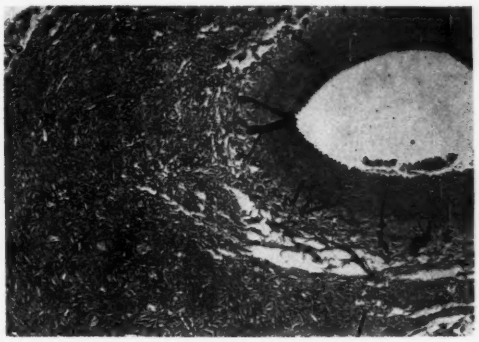


Fig. 2. Photomicrograph ×20 (hematoxylin and eosin stain) of the right carotid artery of dog B-95 six weeks after injection of 1 cubic centimeter of 2 per cent aqueous solution of sodium dicetyl phosphate. Note the prodigious foreign body fibroblastic reaction which was apparent upon examination.

CASE 1. C. T., a white male, 49 years of age, was admitted to the Methodist Hospital on May 28, 1949, complaining of severe dyspnea, dysphagia, and a dry persistent harassing cough. The patient stated that for the previous 3 months he had slept in a sitting position and that he had been "fighting for air." Physical examination, bronchoscopy, x-ray studies and angiocardiogram showed a very large aneurysm of the ascending arch of the aorta which was constricting the trachea and esophagus and which had produced paralysis of the right vocal cord due to pressure on the right recurrent laryngeal nerve. The blood Mazzini and Wassermann tests were 4 plus. On June 4, 1949 ether anesthesia was induced through a small endotracheal tube which had been cautiously introduced through a bronchoscope. As the chest was being prepared for an anterior approach, respirations ceased due to severe bronchospasm. After about 20 minutes of artificial respiration and the use of adrenalin spontaneous breathing was resumed. Two days later the patient decided that he did not wish to risk surgery, and he was released from the hospital. However, he was readmitted on September 14, 1949 because of the persistence and progression of his symptoms.

On September 17, 1949, the patient was prepared for surgery in a sitting position; 1 per cent novocain local infiltration anesthesia was used and sections of the right fourth and fifth ribs were removed close to the spine. The pleura was dissected forward and the aneurysm easily palpated. One hundred cubic centimeters of a 0.9 per cent solution of sodium dicetyl phosphate in olive oil was injected around the aneurysm. The pleura was inadvertently torn during the dissection. It was closed and underwater seal drainage was instituted. The lung re-expanded and after 36 hours the tube was removed. Eight weeks after the injection the patient reported that he was able to sleep lying down and that he was able to swallow without discomfort. He returned to work as a truck driver after 3 months. One year later, September 2, 1950, he was killed in an automobile accident. Pertinent postmortem findings were described by the coroner as follows: "Upon inspecting the heart and great vessels, a large aneurysm of the ascending portion of the aorta was discovered. It was saccular in type and measured 7 inches in its greatest diameter. Some distortion of the other mediastinal structures were present, although none appeared of sufficient degree seriously to interfere with respirations or circulation. The aneurysmal dilatation was confined entirely to the first portion of the aorta. The arch appeared to be grossly normal. The walls of the aneurysmal sac were lined with old, partly organized clots, scar tissue, and calcific deposits. The actual diameter of the lumen through which free blood could flow within the sac was narrowed at points by larger clots to almost normal. The aortic ring was moderately dilated (8½ cm. in circumference). The other great vessels appeared to be grossly normal. Both coronary arteries were the site of moderately extensive calcific deposits and plaques. The aneurysm was intact at all points with no apparent weakening or rupture."

Unfortunately we were unaware of the accident until a follow-up letter was sent in August, 1951. We have been unable to locate the microscopic slides of the aneurysmal sac. However, we were informed that the wall was greatly thickened and showed an enormous amount of scar tissue.

CASE 2. G. B., No. 259559, a colored female 70 years of age, was admitted to the Indianapolis General Hospital on January 15, 1950 with generalized atheromatous arteriosclerosis, hypertension, myocardial insufficiency and an abdominal aneurysm. She had an attack of excruciating left upper ab-

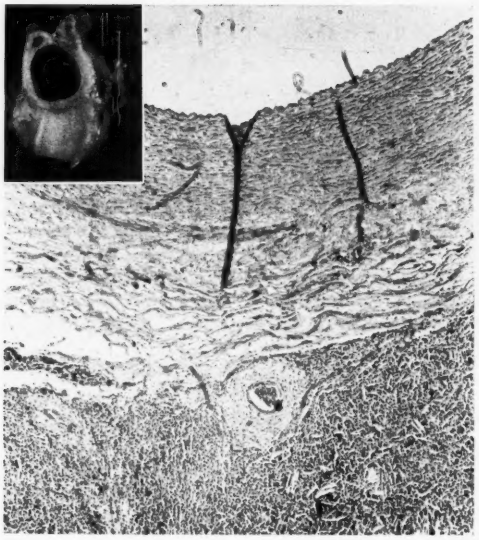


Fig. 3. Abdominal aorta ×41 (hematoxylin and eosin stain) of dog B-99 six weeks after the injection of 7 cubic centimeters of a 2 per cent aqueous solution of sodium dicetyl phosphate in the adventitia. Upper left—photograph showing the controlled injection of the anterior wall only. A portion of the fibroblastic wall is shown. Note the absence of necrosis and the tremendous amount of fibroplasia.

dominal pain 2 weeks prior to admission to the Indianapolis General Hospital and it was thought at this time that the aneurysm had ruptured and that there was extravasation and dissection through its frayed wall. On admission the patient complained of left upper abdominal pain radiating to the back, and nausea. The pain began about 24 hours previously and was constant. The blood pressure was 228 systolic, 124 diastolic, and the pulse rate 72. A large fusiform pulsating tumor about 4 by 10 centimeters could be palpated easily through the abdominal wall and a systolic bruit could be heard with the stethoscope.

Eight days after admission a sudden episode of vertigo, diplopia, and numbness of the right face, right arm and hand occurred which was interpreted as due to a pontine hemorrhage. The patient improved rapidly and was almost asymptomatic within 3 weeks. Laboratory studies showed normal blood counts and urinalyses, and negative serology tests for syphilis. The electrocardiogram was within normal limits but the basal metabolic rate was plus 35. X-ray studies of the chest, gastrointestinal tract, and intravenous pyelograms were normal. The large aneurysm was easily demonstrable on all abdominal films. On February 14, 1950 under ether anesthesia a left paramedian incision was made. The aneurysm was easily identified and was reached

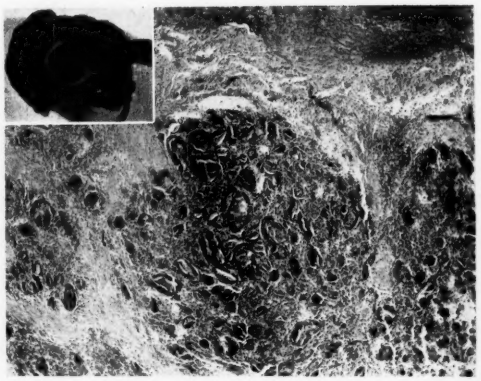
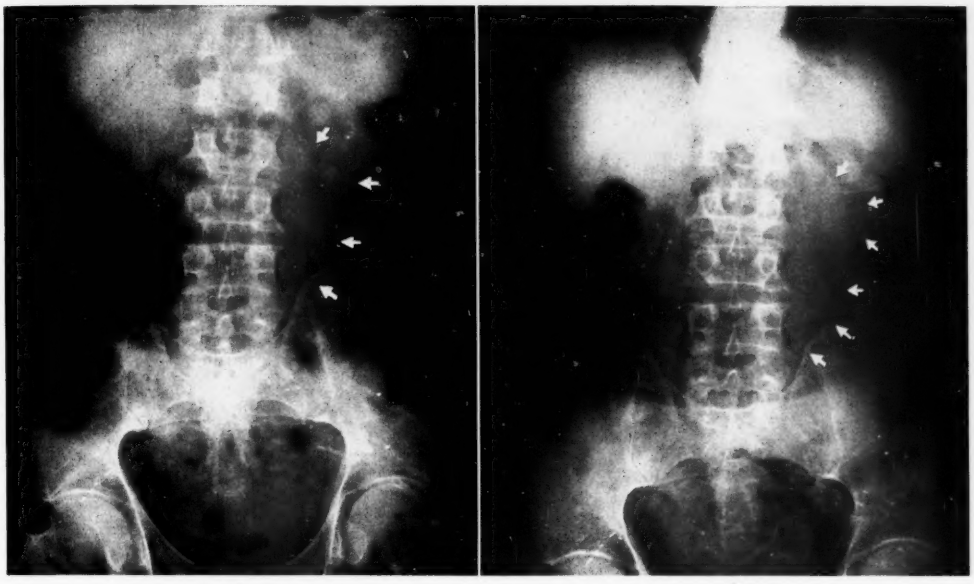


Fig. 4. Photomicrograph ×36 (hematoxylin and eosin stain) and photograph of thoracic aorta from dog B-104 removed 7 weeks after the injection of 10 cubic centimeters of a 2 per cent aqueous solution of sodium dicetyl phosphate. Upper left shows the thick fibrous wall completely surrounding the vessel. The photomicrograph discloses more fibroplasia than is apparent in Figure 3 although there is only 1 week's difference in the length of time which has elapsed since the injection. Note the foreign body reaction, the lack of necrosis and the areas of mature fibrous tissue.

through an incision in the hepatogastric ligament. The entire aorta including the common iliacs were calcified. Many atheromatous plaques were present. There had been a slight leak with dissection of blood among the layers of the aneurysm and there was some reaction around the aneurysmal wall. Ninety cubic centimeters of a 0.9 per cent solution of dicetyl phosphate in olive oil were injected beneath the adventitia around the aneurysm. Small bits of gelfoam were placed over the needle punctures. The hepatogastric ligament was sutured with interrupted No. 000 silk and the abdomen was closed in layers with No. 00 silk. The immediate reaction was very favorable. However, 4 days following surgery the patient complained of severe dyspnea. The blood pressure was 70 systolic and 40 diastolic, and the pulse rate 140. Despite fluid and blood transfusion the patient died in a state of shock. Autopsy was obtained and the pathological findings were as follows: generalized atheromatous arteriosclerosis, focal myocardial fibrosis, localized hemorrhage of pons, small perforation on the posterior wall of the stomach with leakage and peritonitis, cause undetermined; arteriosclerotic aneurysm of abdominal aorta with early foreign body reaction.

The cause of the perforation on the posterior stomach wall is difficult to explain. It was extremely small and there was no inflammatory reaction around it. Such perforations have been reported as a complication of



a b

Fig. 5. a, Mr. E. B., 63 years of age. X-ray photograph showing large saccular aneurysm of the abdominal aorta extending from the second to the fifth lumbar vertebrae. b, X-ray photograph made 1 year after injection of 100 cubic centimeters of 0.9 per cent dicetyl phosphate in oil. Note the increased density although the size remains approximately the same. Patient shows great clinical improvement.

cerebral damage by Cushing. Another explanation was that trauma to the stomach caused by retraction of the organ during surgery may have been responsible. However, it would be difficult to visualize a small, round, punched-out, nonreactive hole due to this type of injury.

CASE 3. E. B., a white male, 63 years of age, was admitted to the Veterans Administration Hospital, Fort Benjamin Harrison on July 11, 1948, complaining of abdominal pain and intermittent claudication. An abdominal aortic aneurysm measuring approximately 4 by 6 inches in diameter could be palpated easily through the thin abdominal wall. X-ray studies showed a duodenal ulcer and a saccular aneurysm from about the second to the fifth lumbar vertebrae with slight vertebral erosion (Fig. 5a). Blood and spinal fluid Wassermann tests were 4 plus. He was placed on a strict ulcer regimen, but his abdominal pain persisted and was only slightly improved at the time of his furlough in September, 1948.

He returned in July, 1950 complaining of intense epigastric distress and cramps in his legs which were of such severity that he could not walk more than 10 yards without excruciating pain. Oscillometric studies were as follows: Ankle R=0, L=0; calf R=0, L=0; thigh R=.5, L=.5. On September 27, 1950 the abdomen was explored through a left paramedian incision. A large aortic fusiform aneurysm was found extending from a centimeter below the renals to the bifurcation. The adventitia was injected with 0.9 per cent dicetyl phosphate in olive oil using approximately 100 cubic centimeters of the solution. The immediate postoperative course was uncomplicated and the wound healed per primam.

The patient was readmitted to the hospital on February 15, 1951 for follow-up studies. The abdominal pain had disappeared entirely but there was very little amelioration of his leg pain on walking short distances. Oscillometric readings were unchanged and a film of the abdomen showed no change in the size or contour of the aneurysm. Palpation of the abdomen gave one the impression that the wall of the aneurysm was more resistant and that its size had decreased. In August of 1951, the patient was readmitted to the hospital and at this time the aneurysm was thought to be smaller in size. X-ray examination showed the aneurysm to be no smaller but more opaque (Fig. 5b). Intermittent claudication had improved materially and the patient was now able to walk some distance without pain although oscillometric readings showed

Fig. 6. H. H., 74 years old. X-ray photograph of large saccular dissecting aneurysm extending from the first lumbar vertebra to the sacrum. Treatment was ineffectual.

little change. The results were as follows: ankle R=0, L=0; calf R=.5, L=.5; thigh R=.5–1, L=.5.

CASE 4. H. H., a white male, 74 years old, came to the Methodist Hospital on September 2, 1950 complaining of severe abdominal pain and vomiting. He had a bilateral herniorrhaphy done elsewhere with partial bowel obstruction following the procedure. Physical examination disclosed recurrent bilateral hernias and a large aneurysm of the descending aorta. X-ray studies showed a penetrating ulcer of the duodenum, with almost complete obstruction. On September 8, 1950 the pyloric antrum and first portion of the duodenum were resected and a Billroth I gastroduodenostomy was used to restore continuity. Microscopic examination showed the ulcer to be benign. Because of the patient's poor condition it was deemed inadvisable to treat the aneurysm at this time. Recovery was smooth and the patient was discharged from the hospital 2 weeks after surgery.

Five months later he returned complaining of excruciating abdominal pain. X-ray examination at this time showed the aneurysm to be larger than on the previous admission (Fig. 6). The severe abdominal pain and distention with absence of bowel sounds indicated a dissecting aneurysm with paralytic ileus. On February 7, 1951 abdominal exploration through a lower left paramedian incision disclosed the previous anastomosis to be entirely patent without recurrence of ulcer. The large fusiform aneurysm extended from a point 2 centimeters below the renal arteries to the bifurcation with some dilatation of the right common iliac artery. Several areas on its lateral wall were soft and hemorrhagic indicating recent dissection. One hundred cubic centimeters of a 2 per cent aqueous solution of sodium dicetyl phosphate were injected around the entire aneurysm and gelfoam strips were placed over each needle puncture. Recovery was prolonged due to a persistent diarrhea which lasted about 6 days but he was able to leave the hospital 10 days after operation. Abdominal pain disappeared in about 3 weeks and the patient felt well enough to take a trip with friends, which he enjoyed. Nine weeks later he returned and was brought to the Receiving Room of the Indianapolis General Hospital in a moribund condition. Before transfusions could be given the patient expired. Unfortunately, autopsy was not obtained; however, we believe that death was due to rupture of the aneurysm.

CASE 5. Treated by Doctors William Tuttle, P. V. O'Rourke, and A. M. Tocker, of Detroit, Michigan. F. M., a colored female, age 39 years, weighing 200 pounds, was admitted to the Harper Hospital with an aneurysm of the ascending and transverse portions of the aortic arch. Her chief complaint was severe chest pain and dyspnea. Her Wassermann test was known to have been positive for a long period of time. On June 22, 1951 at our suggestion the aneurysm was treated by the periarterial injection of 75 cubic centimeters of a 2 per cent solution of sodium dicetyl phosphate. The material was injected very easily and the procedure was described by Doctors O'Rourke and Tocker as being much easier than the cellophane wrapping technique. A report from Doctors William Tuttle and P. V. O'Rourke on December 4, 1951 indicates a highly satisfactory result. Her pain and shortness of breath have disappeared and she has returned to work. X-ray examination at this time shows no increase in size of the aneurysm.

CASE 6. Treated by J. E. Musgrove, Lovelace Clinic, Albuquerque, New Mexico. Mr. J. T. H., a 61 year old male, was admitted to the Lovelace Clinic on September 5, 1951 complaining of a pulsatile mass in the abdomen which caused periumbilical and right sacral pain. This was diagnosed by his family physician as an abdominal aortic aneurysm. This patient had an appendectomy in 1923 and a partial gastric resection for duodenal ulcer in 1945. The Mazzini test was negative. On the 19th of September, 1951 the abdomen was entered through a long left rectus muscle splitting incision. The aneurysm was found to arise from the abdominal aorta below the level of the renal arteries and to extend down to the bifurcation of the aorta. The right common iliac artery was involved, being approximately 1½ inch in diameter. The posterior parietal peritoneum was freed and a heavy elastic band 1 centimeter in width, wrapped in four layers

of irritating cellophane was passed around the abdominal aorta below the renal arteries. The elastic band was then sutured together with three interrupted silk mattress sutures. The posterior aspect of the aneurysm was injected with 15 cubic centimeters of 1 per cent solution of dicetyl phosphate in olive oil from just below the elastic band to the distal end of the right common iliac artery. Irritating cellophane was then applied in strips to the anterolateral surfaces of the aneurysm and anchored in situ with interrupted No. 00000 atraumatic silk sutures. The patient had a satisfactory postoperative course for the first 48 hours, then developed oliguria and azotemia. On the eighth postoperative day he complained of severe abdominal pain and died 10 minutes after the onset of this pain. Postmortem study disclosed a slitlike tear in the anterior convex surface of the aneurysm at a point where its wall was approximately 1 millimeter thick. There was no evidence of encroachment of the renal vessels by the elastic band. Perhaps the removal of the parietal peritoneum and some of the adventitia about the aneurysm was just enough to weaken the wall with the result that followed. This might have been avoided had dicetyl phosphate been used by the injection technique rather than by the open wrapping method.

DISCUSSION

The patients who did not have dissection of the aneurysm wall have shown clinical improvement following the perisaccular injection of dicetyl phosphate. The material is definitely nontoxic and it does induce fibroplasia which is equal in our experience to that of cellophane wrapping. It has in its favor the ease, simplicity, and safety of administration. Perhaps its greatest usefulness will be as an adjunct to other modes of treatment such as partial ligation and the introduction of wire as advocated in abdominal aortic aneurysms by Blakemore; or in conjunction with cellophane wrapping which may be used on the "free" sides of the aneurysm using the injection posteriorly or at points of attachment where dissection is hazardous. Aneurysms which cannot be treated safely by combined methods may be reinforced by the fibroplasia which results from the injection of sodium dicetyl phosphate.

CONCLUSIONS

Sodium dicetyl phosphate produces fibroplasia with minimal necrosis of tissue when injected around blood vessels. It may be used to induce fibroplasia around large aortic aneurysms alone or in conjunction with other methods of treatment.

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RADICAL ABDOMINAL PROCTOSIGMOIDECTOMY WITH PRESERVATION OF THE ANAL SPHINCTER

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SURGEONS have attempted to devise operations since the beginning of the modern era of surgery so that the anal sphinoter could be saved in extirpating carcinomas of the lower colon and rectum. In 1885, Kraske created considerable interest in this subject when he described his method of sacral excision for carcinoma of the rectum in which operation the tumor was excised through the sacrococcygeal route and a direct end-to-end anastomosis performed. In 1889, Hochenegg devised his "pull through" procedure which consisted of partially freeing the lower colon and rectum and pulling this whole segment, including the tumor, through the split anal sphincter. After several days of waiting for healing to take place, the excess bowel including the tumor was excised and what was essentially a perineal colostomy was created. In 1892, Maunsell reported an operation in which he mobilized the bowel through the abdominal route and, after intussuscepting the bowel through the split sphincter, excised the bowel containing the tumor. A crude type of anastomosis was performed after which the prolapsed bowel was replaced within the pelvic cavity. Weir, in 1901, improved upon this technique by excising the tumor from above. He then everted the closed end of the lower rectal segment through the anus from below, pulled the upper colonic segment through the latter and performed a single layer anastomosis. Many other surgeons have tried a variety of procedures of this type. None of them have proved to be eminently satisfactory. The first objection to these procedures is that they are often inadequate for the radical treatment of cancer. Secondly, either functional sphincter control has not been good or the complication of rectal stricture and fistula have followed too frequently. More recently, Babcock and Bacon have continued with a "pull through" type of rectal resection. Their technique includes splitting the anal sphincter. Functional continence does not follow in all cases. The aims of sphincter saving operations are two, if they are to be worthwhile. First, the surgical excision must be adequate and compare favorably with operations which do not preserve normal gastrointestinal continuity. Secondly, complete continence which should include an ability to withhold gas as well as feces must result. Otherwise, the patient is better off with an abdominal colostomy.

In this communication we shall present our experience with a type of "pull through" technique for resection of lesions in the rectosigmoid which fulfills these requirements more adequately than many other procedures. The indications for the use of sphincter saving procedures are of primary importance since preservation of bowel function should never be the first consideration in planning an operation for cancer. The technique will be described first after which the indications for its use in our hands will be discussed.

In 1948, Swenson described a technique for resection of the rectosigmoid for Hirschsprung's disease based on a new concept of its etiology. In this operation a very low rectal anastomosis is made with preservation of the anal sphincter. It is followed by complete continence in these patients with Hirschsprung's disease. The operation to be described herewith for cancer of the rectosigmoid is adapted directly from the technique of Swenson, and modified only in order to increase the extensiveness of the resection. We have used this technique for resection of rectosigmoid carcinomas in a selected group of patients.

From the Surgical Service, Pratt Diagnostic Clinic, New England Center Hospital and the Department of Surgery, Tufts College Medical School, Boston, Massachusetts.

TECHNIQUE OF OPERATION

Abdominal exploration and abdominal dissection is first performed. If metastases are found in the liver or if there are other metastases which deny the possibility of cure, this procedure should not be used. Instead, the conventional abdominoperineal resection with colostomy or anterior resection with intra-abdominal anastomosis is the better choice, for, as shall become evident, the operation to be described requires a more extensive mobilization and resection of the left colon than is required for palliative treatment. The second major division of the operation is the anastomosis of the mobilized left colon to the small rectal cuff. This is done by a second team working below in the perineal region while the abdominal team reconstructs the pelvic floor and closes the abdomen.

In order to obtain a quiet operative field the patient is intubated, the endotracheal tube being inserted under light pentothal anesthesia combined with the administration of curare. The patient is then maintained on a cyclopropane-oxygen mixture or, in case heart block exists, pentothal is continued and ether is added to this mixture. The patient is placed in lithotomy position. In Figure 1, it can be seen that stirrups or conventional knee rests are not used. They are dangerous since long continued pressure during the course of the operation may result in perineal nerve paresis. Instead, we employ a bent metal rod similar to the so-called "ether screen" but larger. The legs are suspended from this frame by means of adhesive strapping in such a manner that the rod makes no contact with the patient. Gauze padding may be used if desired to protect the lower extremities further. The feet are spread and strapped each to a narrow board which is anchored under the mattress by the weight of the patient. This position brings the perineum on a plane with the end of the table and provides sufficient working space for the team doing the anastomosis below.

The indwelling urinary catheter is led into a rubber glove which is strapped to the midthigh. The entire skin of the abdomen, perineum, lower thighs, and exposed buttock is prepared as a unit, by using a 3 minute scrub

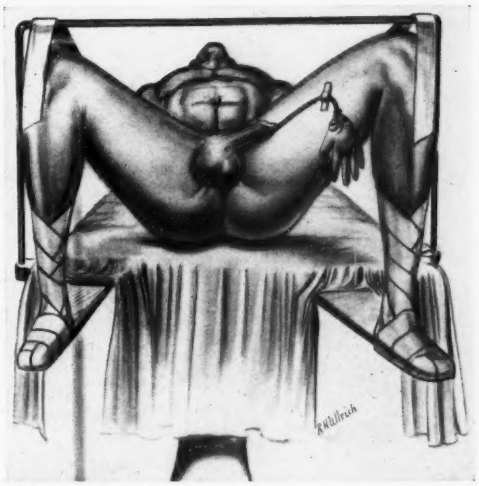

Fig. 1. Position of the patient on the operating table. Note that the legs are not in contact with the supporting bar. The abdominal incision is outlined.

of *p*Hisohex followed by three changes of 1:1000 aqueous zephiran solution. The field is draped with towels and half sheets in such a manner that when the second stage of the operation is reached, exposure of the perineum is obtained by removing only the half sheet covering the legs without disturbing the abdominal drapes or contaminating the abdominal wound.

The abdomen is opened through a suprapubic midline incision with extension to the left of the umbilicus splitting the sheath of the left rectus muscle. Abdominal exploration is performed. The patient is then placed in Trendelenburg position and the small intestine is packed away with moist laparotomy pads. The sigmoid colon is drawn upward and the pelvic peritoneum is incised laterally and anteriorly preliminary to mobilization of the rectum. Both ureters are exposed and identified. The superior hemorrhoidal artery is ligated at its origin and the rectum and rectosigmoid are mobilized posteriorly down to the coccyx in the usual manner. After separation of the rectum from the hollow of the sacrum, the anterior dissection of the rectum from the vagina or prostate and urethra is performed. The lateral rectal stalks with the middle hemorrhoidal vessels are divided as far lateral

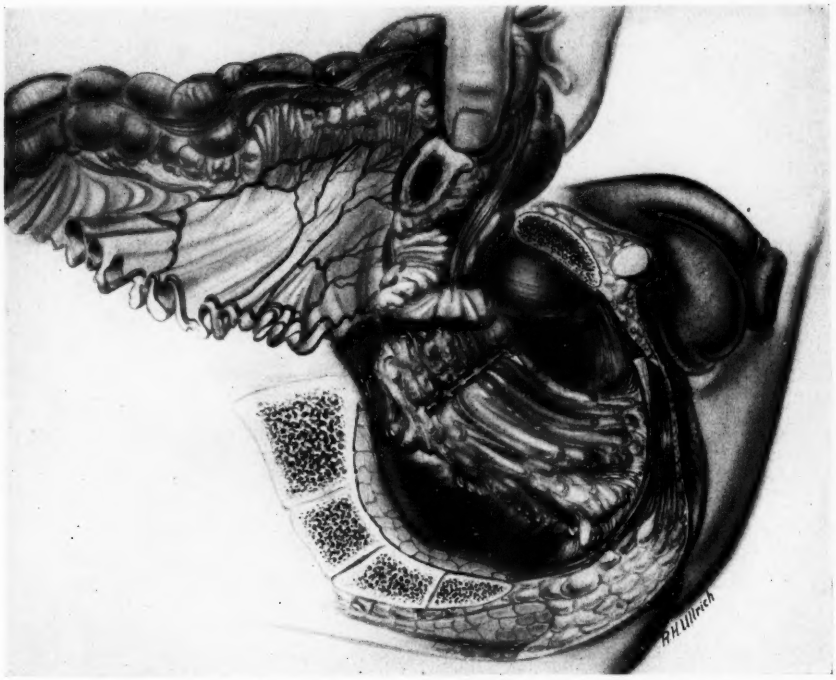

Fig. 2. Sagittal section showing a cancer of the rectosigmoid just above the pelvic peritoneal reflection. The extent of the pelvic dissection is shown. The bowel will be divided between the von Petz clips which have been placed 6 centimeters below the tumor.

to the rectum as possible and the levator ani muscles exposed. Up to this point the dissection is identical with that of the conventional abdominoperineal procedure. At this time the surgeon can review his decision for this operation and may elect to proceed with the conventional abdominoperineal procedure if he is dealing with a very large and extensive growth or if the tumor is situated low in the pelvis. If extrarectal extension in the pelvis is not present, the rectum is divided 4 to 6 centimeters below the tumor and the von Petz clamp used (Fig. 2). The distal segment of rectum is dropped into the pelvis and covered with a moist pad.

The next two steps in the operation are the mobilization of the entire left colon and the radical excision of its mesentery. The first step is accomplished by incision of the lateral reflection of the peritoneum up to the splenic flexure. Further mobilization is secured by severing the gastrocolic omentum superiorly. This is done as far medially as seems necessary to insure that the splenic flexure may reach the promontory of the sacrum when it is pulled down after mobilizing the left side of the colon. It may be necessary at times to sever the gastrocolic omentum before the entire splenic flexure can be conveniently mobilized. With adequate mobilization of the colon, the splenic flexure, descending colon, sigmoid, and rectosigmoid stump may now be brought outside of the abdomen and dissection of the mesentery of the left colon completed in the following manner. The severed rectosigmoid is grasped and pulled upward and laterally exposing the base of the mesentery and the bifurcation of the aorta. It is possible to proceed with removal of the lymph node bearing tissue about the aorta and inferior vena cava from the common iliac arteries upward to the base of the transverse mesocolon. If this dis-

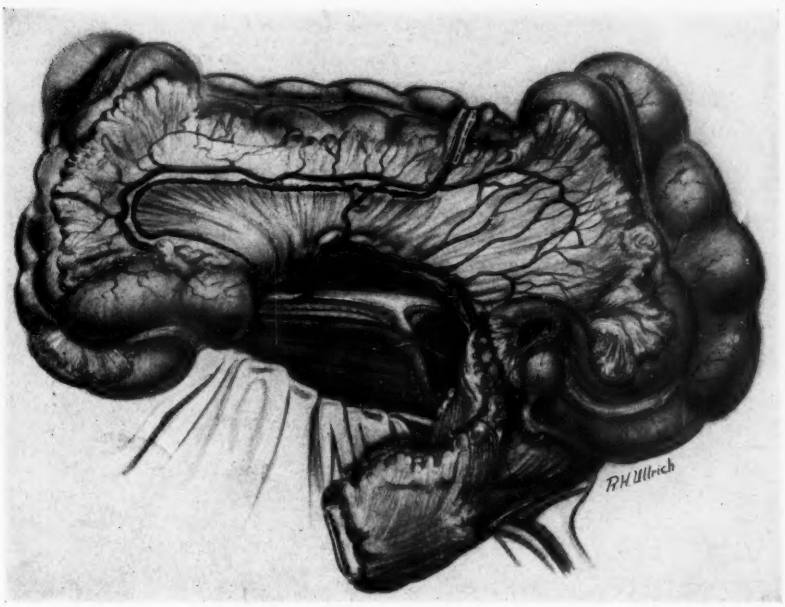

Fig. 3. The extent of the abdominal dissection is seen in this sketch. The aorta has been exposed and the inferior mesenteric artery ligated. Note the extensive resection of mesentery with preservation of the marginal arteries which will supply the left colon with blood from the middle colic artery. The colon has been divided between von Petz clips at the beginning of the ascending sigmoid colon.

section is carried out in the right plane very little bleeding is encountered and the operation proceeds rapidly. As the dissection is continued superiorly the inferior mesenteric artery is severed close to its origin, isolating the mesentery of the sigmoid and the descending colon. Thus, the inferior mesenteric and all its branches are sacrificed. The blood supply to that portion of the left colon which is to be preserved and utilized for anastomosis to the rectum is now maintained by the middle colic artery by way of the marginal arteries of the left colon. After the inferior mesenteric artery has been cut, a portion of the relatively avascular mesentery above it can be sacrificed, but care must be taken not to injure the marginal anastomotic vessels in the splenic flexure and descending colon. In Figure 3, the extent of the mesenteric dissection is outlined. It should be noted that in most instances the entire sigmoid is removed, and a large portion of the mesentery and lymph node bearing tissue of the colon superior to the sigmoid is also removed. After the extent of the mesenteric excision has been defined, transection of the bowel is made usually in the descending colon or at the junction of the sigmoid and descending colon. It should be stressed that mobilization of the colon laterally and superiorly must be adequately performed in order to allow this extensive excision while at the same time permitting the anastomosis to be made without tension. Transection of the left colon is performed using the von Petz clamp. The ease of performing the colonic rectal anastomosis depends to a large extent on extensive mobilization of the left colon and the adequacy of its blood supply.

Anastomosis of the proximal colon to the rectal stump is accomplished in the following manner. The perineum is exposed by removing the lower half sheet and a second operative team is brought in to perform the anastomo-

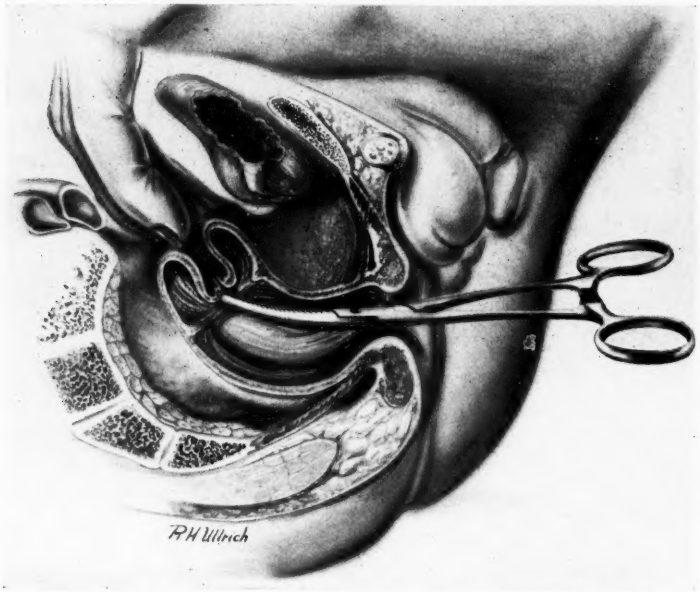

Fig. 4. Sagittal section showing the beginning of the perineal phase of the operation. The operator below has passed a long curved clamp through the anus into the rectal stump. The surgeon working in the abdomen must guide the rectum into the instrument. This will avoid tearing of the rectum with resulting contamination of the pelvic cavity.

sis. The team working in the perineal region must now turn the lower rectal stump inside out with the help of the abdominal team. A long, curved forceps is inserted into the rectal stump through the dilated anal orifice and the closed end of the rectum is grasped and pulled down through the anus so as to turn it inside out (Fig. 4).

The everted rectal stump and perineum are cleansed with *p*HISOHEX followed by five changes of aqueous zephiran solution. A transverse incision is made in the everted rectum 3 centimeters from the anus, sufficiently large to allow the proximal colon to be pulled through it. Through this incision a long sponge forceps is passed into the pelvic cavity for the purpose of pulling the upper colon through the rectal stump (Fig. 5 insert). The proximal end of colon is guided into this forceps by the surgeon above. Care must be taken not to twist the bowel during this maneuver. The proximal colon is grasped and is drawn downward through the sphincter and the incision in the everted segment of rectum. Great care should be taken to remove excess fat and mesentery from both segments in the area selected for the anastomosis. A seromuscular layer of interrupted sutures of silk is placed and tied approximating the serosal surface of the proximal colon which is innermost to the muscularis of the everted rectum with which it is in contact. As these sutures are placed, the everted portion of rectum is trimmed away in a circular manner at the same distance from the anus (3 centimeters) as the original transverse rectal incision. Several of these sutures should be kept long and held since there is a tendency for the bowel to retract through the anus (Fig. 5). Each suture must be accurately placed and should be no more than 2 millimeters apart. After this layer is completed the proximal colon is opened transversely 1 centimeter distal to the above placed sutures. This additional amount of proximal colon with the von Petz clips attached is trimmed away.

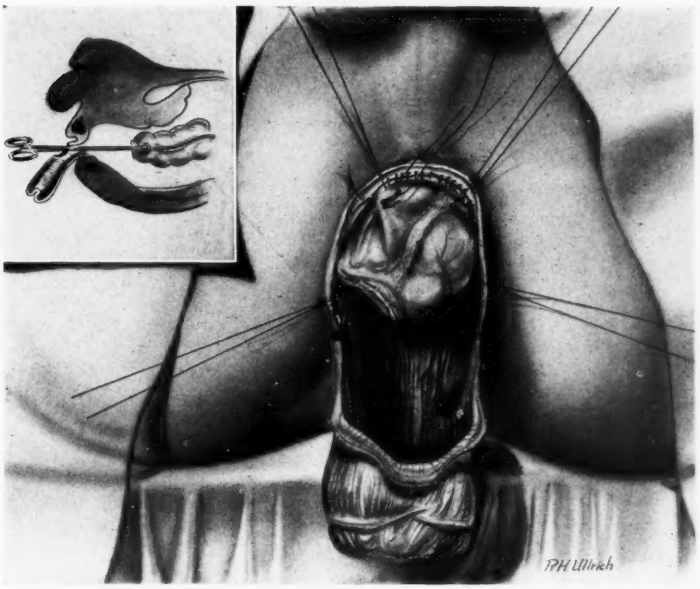

Fig. 5. In the insert the everted rectal segment has been incised transversely. A sponge forceps has been passed through this incision and the proximal colon firmly grasped. The surgeon above in the abdomen helps to guide the proximal colon through the perineum. Care must be taken not to twist the bowel. The colon has been pulled through the incision in the everted rectum and the seromuscular layer of sutures is laid down. Sutures must be carefully placed 3 millimeters apart.

The adequacy of the blood supply of the proximal colon can be tested again by observing bleeding. The exposed mucosa is sutured to the everted mucosa of the rectum with a layer of fine interrupted catgut sutures thus to complete the second layer of the two layer anastomosis (Fig. 6). When the anastomosis is completed all held sutures are cut and the bowel is allowed to retract through the anus. The suture line then occupies a position approximately 3 centimeters from the mucocutaneous border (Fig. 7).

As the anastomosis is being performed below, the abdominal team reconstructs the pelvic floor suturing the lateral pelvic peritoneum to the colon. Hemostasis should be complete in the pelvic cavity and the abdomen is closed without drainage. If there has been contamination of the pelvic cavity or incomplete hemostasis, it is wise to insert a cigarette drain into the presacral space and to bring it out lateral to the coccyx through a stab wound in the perineal region. Proximal decompression of the bowel is not usually performed. In certain instances when there is doubt of the quality of the blood supply to the bowel, when there may be a little tension present, or when the anastomotic suture line is not entirely satisfactory a colostomy should be made. None of these circumstances should be present in the ideal operation. Nevertheless, proximal colostomy performed in the right transverse colon should be done if any doubt arises about these factors.

SELECTION OF CASES

The selection of patients whose lesions are suitable for this operation must be carefully made. Only tumors ordinarily considered by us to be suitable for so-called "anterior resection" with anastomosis are considered for resection by this procedure. Such lesions are at or just above the pelvic peritoneal reflection. In selected cases small lesions just below the

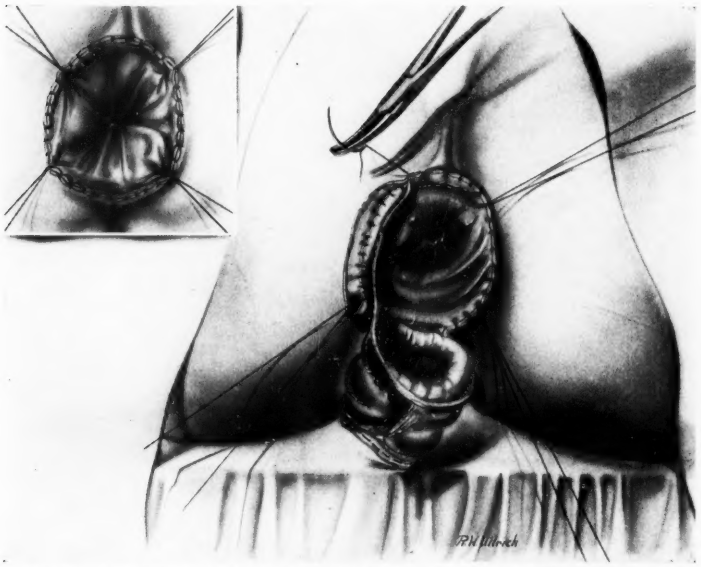

Fig. 6. The seromuscular layer of sutures has been completed. The proximal colon is open just above the von Petz clips and the mucosal layer of sutures is placed. Note the traction sutures which prevent withdrawal of the bowel into the pelvis. The insert shows the second layer of sutures completed. The anastomosis is now ready to be returned to the pelvic cavity.

pelvic floor are also suitable. It is most difficult to decide if this technique can be used for resection of a lesion before celiotomy since proctoscopic examination does not give a true measurement of the anatomic site of rectal growths. In general, cancers of the rectum or rectosigmoid situated 14 to 16 centimeters or more from the anal margin on proctoscopic examination may be suitable although final evaluation of the situation and decision for the operative procedure must be determined at the time of operation. This operation should not be used to replace the combined abdominoperineal resection with permanent colostomy for the lower rectal lesions since the frequent lateral and occasional retrograde metastases occurring low in the pelvis are more certain of adequate removal when the rectum and anus with the medial portion of levator ani muscle group are entirely removed. Patients with such rectal lesions must accept permanent abdominal colostomy for the greater security derived from complete abdominoperineal rectal resection.

PREOPERATIVE PREPARATION

The preoperative management of patients with carcinoma of the rectum and rectosigmoid is essentially the same for this operation as for other colonic surgery. There are a few aspects of preparation which deserve emphasis, however. The involvement of the ureters by extension of the primary growth with obstruction and resulting hydroureter and hydronephrosis is infrequent, but important to recognize. Preoperative intravenous pyelograms are valuable in order to determine the status of the upper urinary tract at the time of surgery. Changes in the pyelographic findings at a later time may indicate recurrence of cancer in the retroperitoneal area and deep pelvis. A record of the original status of the upper urinary tract is, therefore, valuable for comparison. It is desirable that patients in the age group for prostatic disease be evaluated by the urologist in order to anticipate any postoperative urinary difficulty. A significant number of these patients have postoperative bladder dysfunction. This may be

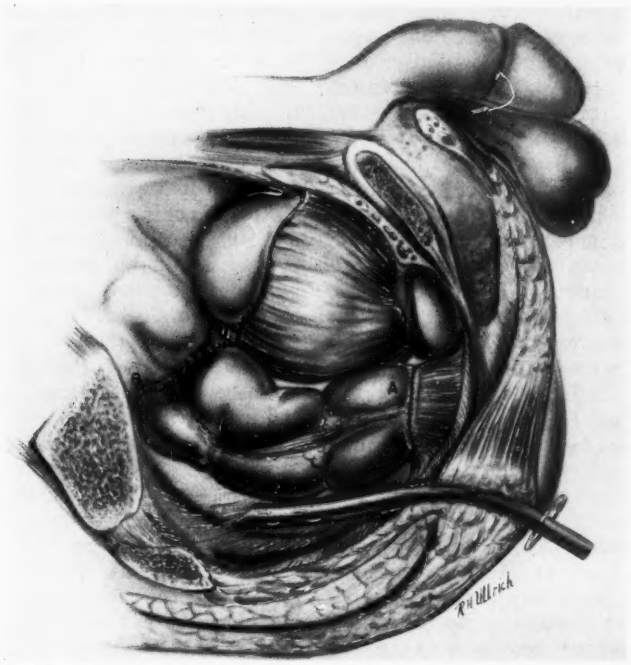

Fig. 7. Sagittal section showing completed operation. The peritoneal floor has been reconstructed. The anastomosis lies just above the levatores ani muscles. A drain is placed into the presacral space through a perineal stab wound. *A* represents the line of rectal colonic anastomosis. *B* indicates the site of reconstruction of the pelvic floor.

due to either an unrecognized prostatic obstruction or this in combination with neurogenic dysfunction. Displacement of the bladder base posteriorly is another associated cause of bladder dysfunction.

Not only should biopsy of the lesion be performed by proctoscopy when possible, but barium enema is indicated in all but highly obstructing lesions in order to detect multiple tumors. The usual 4 to 7 day regimen of low residue diet, colonic cleansing, and chemotherapy is used. Penicillin and streptomycin, or more recently terramycin, are given 48 hours preceding surgery in addition to the sulfathalidine. Hypoproteinemia and anemia are corrected by blood transfusions. Blood volume determinations are useful in determining the patients' needs for blood replacement if they are debilitated and have lost much weight. On the evening before surgery, an inlying urethral catheter is secured in the bladder and a Levin tube is inserted and secured in place.

RESULTS OF OPERATION

Since January, 1950, we have performed the operation described on 12 patients with lesions of the rectosigmoid or low sigmoid. The first patient operated upon by us, using this technique, has been observed 22 months at this writing. Only 10 per cent of cancers of the rectum seen in this hospital were suitable for resection by this technique during the same period. The combined abdominoperineal excision with permanent colostomy was the operation of choice in the majority of our cases. Ten of the 12 resections were performed for carcinoma, 1 for a large sessile rectal polyp, and 1 for extensive stenosing diverticulitis extending into the rectum. All

of the 10 patients with carcinoma had lesions which were judged resectable for "cure." The operation was not used as a palliative procedure. In 7 other cases, this operation was planned but because of extensive metastases or wide extension of the tumor growth, a simpler procedure, either anterior resection or the combined abdominoperineal resection was done as a palliative measure. In the 10 patients with malignant lesions who had resections performed by this method, proctoscopy showed the tumor to be from 11 to 18 centimeters from the anus. However, as we have stated, measurements from below by proctoscopy are not so significant as the abdominal findings in judging whether or not the resection should be done. The 1 patient with a benign tumor operated upon by this technique had a lower lying lesion (8 centimeters). In 1 patient, 2 separate carcinomas were present in the specimen. Three of the 12 patients developed leaks in the posterior aspect of their suture line with resulting presacral infection. This complication can be ascribed to faulty technique and has not occurred in those patients in whom every detail of the technique described was carried out. Convalescence was delayed in these patients, but conservative therapy resulted in satisfactory healing without the need of temporary proximal colostomy. In another case, a transverse colostomy was made at the time of operation because of a feeling of insecurity of the anastomosis. In this case, the anastomosis was performed and too long a distal segment was used with an undoubtedly deficient circulation. This patient developed a presacral abscess following breakdown of the posterior aspect of his suture line. At the present time, 6 months postoperatively, he has a stricture in this area, 6 centimeters from the anus, but the rectal anastomosis is patent as determined by through-and-through irrigation. In 1 case in which resection was performed for diverticulitis, a colostomy was already present. In 9 cases the anastomoses have healed promptly. One patient suffered an acute cystitis as a postoperative complication; however, this condition cleared promptly after appropriate antibiotic treatment was instituted.

All patients complained of diarrhea in the immediate postoperative period. The number of movements have varied from 2 to 10 daily and in 3 cases, numerous bowel movements have been a very troublesome complication. However, the diarrhea has never persisted longer than a month. Patients can be assured that it will stop within that period of time. Sphincter control with normal anal continence has not been present in the immediate postoperative period in any of our patients. Four patients had good control within 6 weeks of the operation. At the present time, all 10 patients who do not have temporary proximal colostomies report that they have normal bowel function as far as anal continence is concerned. All except 1 patient can hold and pass flatus without soiling themselves.

The average postoperative stay in the hospital is 21 days which is longer than the average for combined abdominoperineal resections and is slightly longer than for patients with anterior resections. However, with more experience with the procedure, complications have been fewer and the morbidity lower.

POSTOPERATIVE CARE AND COMPLICATIONS

Antibiotics in the form of adequate doses of penicillin and streptomycin are given routinely in the postoperative period for 5 to 7 days. Gastric suction is maintained for a period of from 3 to 4 days or until flatus is passed. The patient usually has small, frequent fluid stools beginning on the fourth to sixth day. The diarrhea may continue for a period of 4 to 5 weeks and is modified by using low residue diets and paregoric. Urinary drainage is maintained for a period of 6 to 7 days. The same problems of bladder dysfunction are present as are found following the classical Miles abdominoperineal resection although perhaps to a lesser extent. This difference is thought to be due in part to the fact that the bladder is supported to some extent by the colon posteriorly and that a dependent pocket in which urine may be retained below the level of the bladder outlet is not produced as frequently. Early correction of bladder neck obstruction by transurethral resection is indicated when significant amounts of residual urine persist.

DISCUSSION

A number of excellent studies of the extramural lymphatic extension of cancer of the rectosigmoid have demonstrated that the spread is invariably upward (2, 3, 4, 9). Retrograde or downward extension occurs in only a small percentage of cases and then usually when there is blockage of the superior lymphatics by previous upward metastases. The extensive superior excision of the mesentery and the gland bearing area in the procedure described in this communication fulfills adequately the requirements for a good cancer operation for rectosigmoid growths. The necessity for securing an adequate length of colon for the low anastomosis outside the anus requires complete lateral mobilization of the left colon and severance of the left portion of the gastrocolic omentum. Moreover, it is necessary to sacrifice the inferior mesenteric vessels in order to effect the additional mobilization needed to perform the colonic rectal anastomosis at so low a level. The excision represents an almost complete removal of the left colonic mesentery. This additional left colonic mesentery excision and para-aortic gland dissection should contribute to a more certain removal of metastases. In cases in which mobilization of the left colon is adequate the splenic flexure rests on the promontory of the sacrum without tension when the anastomosis has been completed. The lateral spread of rectal cancers situated below the pelvic peritoneum precludes employing this procedure.

It is recognized that this technique presents operative difficulties not encountered in the usual combined abdominoperineal resection with colostomy or in the operation of anterior resection for carcinoma of the lower colon and upper rectum. A serious complication of this procedure is rectal stricture. This should not occur if the technique has been perfect in all respects. On the other hand, stricture is a recognized complication of low rectal anastomosis. Swenson has reported 1 stricture in 31 patients with this type of primary resection performed for Hirschsprung's disease. He attributes the complication to tension on the suture line and overcame the difficulty in this case by a short course of digital dilatation. It is believed that stricture formation can be obviated by assuring that the blood supply to the bowel is adequate, that the anastomosis is under no tension, and that all sutures are accurately placed.

This procedure also removes the rectum and perirectal tissue at a lower level than the conventional anterior resection with transabdominal anastomosis. The intestine is sacrificed flush with the levator ani muscles. The manner in which the anastomosis is performed outside the abdomen, by working below with the lower segment temporarily pulled inside out, makes a very low union rather easy. The fact that the anal sphincter is not cut and that the rectum is intact to the level of the levatores ani is responsible for the good functional results achieved.

The middle colic artery remains as the sole blood supply to the distal colon via the marginal collateral vessels. The adequacy of this supply is easily tested by observing the quality of bleeding from the proximal end of the colon during the operation. When inadequacy of blood supply exists it is usually not in the proximal colon but rather in the rectal stump. Leaving too long a lower rectal segment is to be avoided since it is in this segment that the blood supply may be poor.

SUMMARY

A technique for resection of cancer of the rectosigmoid with preservation of the anal sphincter has been described. Special features of the procedure include a radical superior dissection and excision of the sites of lymphatic metastases and a low rectal amputation with anastomosis. The selection of patients whose lesions are suitable for resection by this method has been discussed. The complications and functional results in 12 patients upon whom this operation has been performed have been presented.

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COARCTATION OF THE LOWER THORACIC AND ABDOMINAL AORTA IMMEDIATELY PROXIMAL TO CELIAC AXIS

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SURGICAL treatment of coarctation of the distal thoracic and proximal abdominal aorta partially involving, or immediately adjacent to, the celiac axis presents many technical difficulties. None of the accepted methods for repair of coarctation are applicable for lesions in this region. For this reason, when these rare cases are encountered they are deemed inoperable. Because of the poor prognosis in coarctation, a radical procedure was justified in the case presented herein. When the constriction is directly adjacent to the celiac-aortic junction, a cuff of vessel is not available for anastomosis; thus, correction cannot be accomplished either by the usual end-to-end anastomosis, with or without the use of a free arterial graft, or by swinging down the subclavian artery as performed for coarctation in the region of the isthmus. A by-pass graft is not practical because of regional anatomical relationships; for example, the root of the mesenteries and the renal, adrenal, mesenteric, and hepatic vessels, with the viscera they supply, limit the space available for performing a satisfactory anastomosis. The method we have employed to meet these complicating factors consists of resecting the spleen, freeing the splenic artery distally, and anastomosing the distal end of the splenic artery to the side of the lower thoracic aorta just proximal to the constricted area.

Anastomosis of the splenic artery to the aorta has several advantages. (1) The operative procedure is shortened since only one anastomosis is required; an excellent anastomosis with less possibility of obstruction or thrombosis is already present distally at the celiac-splenic junction. (2) The reverse blood flow through the large splenic artery, which in this case possessed a lumen of the same size as that in the coarcted area, more than doubles the blood supply below the stricture. (3) The blood that normally would have supplied the spleen is no longer extracted from the abdominal aorta but is added to the blood supply of the liver, intestines, and kidneys where it is most needed.

The incidence of coarctation involving the distal thoracic and abdominal aorta is difficult to determine because of many factors, such as, lack of autopsy permission and recorded detail concerning the exact coarctation locale when observed in postmortem examination. The lesion is undoubtedly very rare, but with increasing knowledge regarding the pathology, diagnosis, and treatment more cases will be reported.

Abbott's excellent study of 200 recorded cases of congenital coarctation of the aorta mentioned only 5 located in atypical sites; of these, 4 were of the arch proximal to the left subclavian artery. The fifth was in the lower thoracic region. Bahnson reported 2 cases, one of the midthoracic aorta and the other below the renals. His bibliography referred to 10 additional cases in which the coarctation was in an unusual site. One of these, described by Costa, referred to a coarctation at the level of the first and second intercostal arteries. Since these vessels arise from the subclavian artery, it is presumed that the site of stricture was at the level of the third and fourth intercostals, which would place the coarctation in the region of the isthmus, or just below, and it would thus fall into the typical group. Another of these mentioned by Hickl was located just below the isthmus. Included in this series was a case reported by Baylin which appears to be an aneurysm with obstruction just distal

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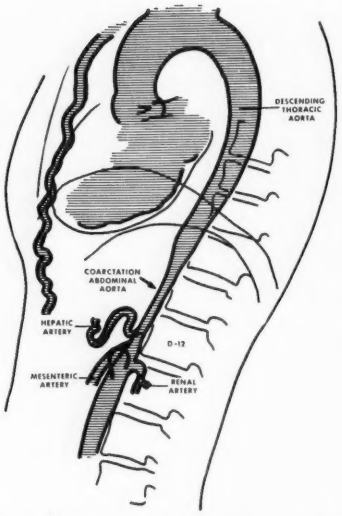


Fig. 1. Preoperative angiocardiogram tracing.

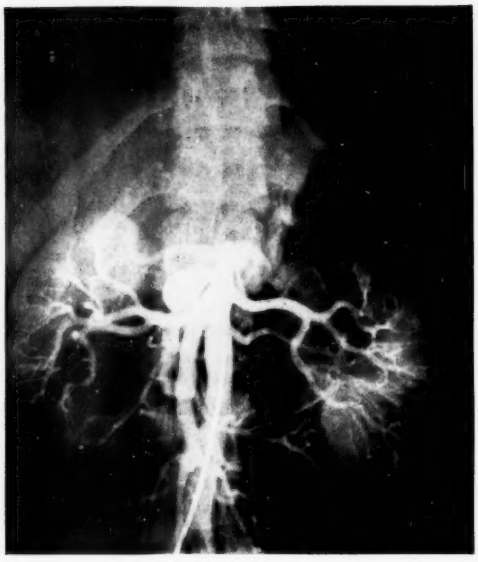


Fig. 2. Preoperative retrograde abdominal aortogram with catheter introduced through right femoral artery (see Fig. 3).

to the renal vessels and probably of the idiopathic thrombotic type similar to that described by Leriche. Powers' case was probably of this type rather than a congenital coarctation. In addition to the 5 cases mentioned by Abbott only 11 cases have been reported with sufficient detail to be classified as atypical sites of coarctation below the aortic arch.

The first coarctation of the lower thoracic aorta, we believe, was reported in 1835 by Schlesinger, and is the lower thoracic case mentioned by Abbott. The others were reported by Hasler, Hahn, and Schleckat. Hahn and Schleckat reported the same case. One case each was reported by Maycock, Steele, Olim, Beattie, Kondo, and Freeman. Robb shows in his book, a lateral angiocardiogram of the case reported in this paper. A lower thoracic coarctation ending at the level of the tenth thoracic vertebra was recently encountered by Humphreys and Deterling. The coarctation reported by Kondo was located between the celiac and the renal arteries; the surgical procedure described in this paper, if slightly modified, would be applicable. Case 2 in Freeman's paper, reported as inoperable, appears to have a coarctation located in the same area as that in our patient.

The high mortality of untreated coarctation of the aorta, including all degrees of obstruction, as emphasized by Abbott, namely that 27 per cent will die by the age of 20 years, 52.5 per cent by 30 years, and 75 per cent by 40 years of age, and the almost complete reversal of the disease process by adequate surgery, makes some type of treatment obligatory. A procedure which completely relieves the obstruction is the most desirable, but in some instances may be impossible. Even partial relief of the obstruction definitely increases the patient's life expectancy and should be done when feasible. Gratifying results obtained by this type of treatment are detailed in the following case report.

CASE REPORT

The patient, a 19 year old white girl, was admitted for the first time to the Surgical Department of The New York Hospital—Cornell Medical Center on November 26, 1950. Her chief complaints were a growth on the left side of the face, present since the age of 2 years, and high blood pressure of 10 years' duration.

History of present illness. The patient's skin always had been darkly pigmented, with *café au lait*

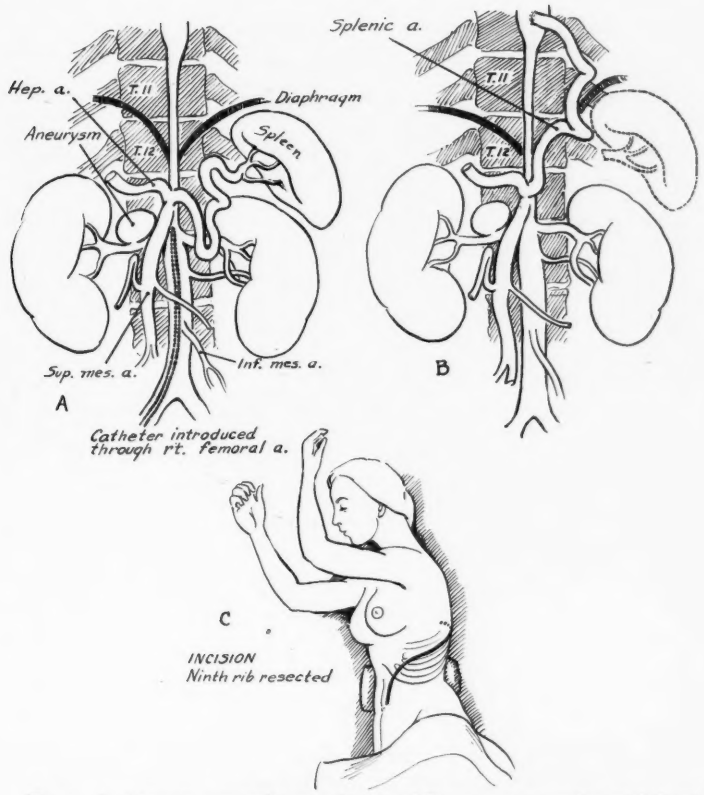


Fig. 3. A, Accurate composite reproduction of Figure 1, preoperative pathology. B, Accurate composite reproduction of postoperative pathology (Fig. 8). C, Operative incision.

spots, multiple neurofibromas (von Recklinghausen's disease). A pachydermatocele involved the left side of the neck, inferior aspect of the left cheek and ear, and adjacent areas of the shoulder and chest. This growth was stated to be present at birth as multiple hemangiomas which soon coalesced into a single large tumor, slowly increasing in size after the patient reached the age of 2 years. Numerous plastic procedures between the ages of 4 and 19 years failed to check growth of the tumor. High blood pressure, first noted at the age of 10, was reported as 220/175 millimeters of mercury in the arm. In 1946 a bilateral thoracolumbar sympathectomy was performed in another hospital, which, for a short period, produced a fall in blood pressure. Hypertensive symptoms were mild at first and gradually increased to moderate severity. On admission to New York Hospital, the patient had two flight exertional dyspnea on climbing stairs and intermittent claudication on walking up hill. She walked slowly and was easily fatigued with resultant pain in the calf muscles of both legs. She never had been able to run nor keep up with other children in play. At times she had palpitations, headaches, transient precordial chest pain, and difficulty with sleeping. She had never noted orthopnea, ankle edema, nor unusually cold feet. She did not complain very much of these symptoms but she was very nervous and sensitive about the disfiguring pachydermatocele and was most desirous of obtaining cosmetic repair. She had never menstruated, but had periodic crampy, low abdominal pains at 2 to 7 week intervals which last for a day or two.

Family history. Both parents were of the Hebrew race. The patient's father was born in Russia and died at the age of 50 of diabetes. Mother was living and well, as was her only sister who had no similar disease nor abnormalities. The remaining family history was noncontributory.

Past history. The patient was born in New York City and had always lived in the vicinity. Her birth had been a normal spontaneous delivery and growth

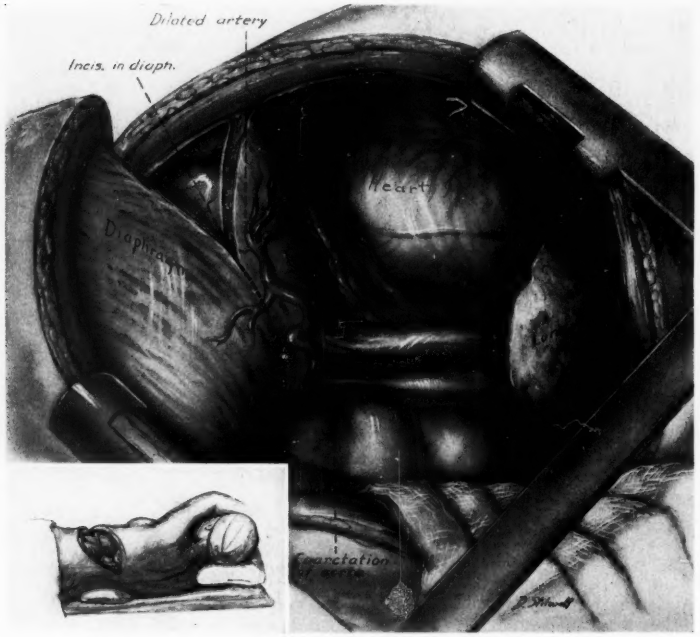


Fig. 4. Operative procedure—initial stage.

was normal. She had the usual childhood diseases and was treated for "pneumonia" at the age of 2 weeks. The patient had always been small in stature and normally proportioned. Her weight had been average for her age and size.

Systems' review. At times the patient had severe nose bleeds, and hearing in the left ear was impaired owing to encroachment upon it by the pachydermatocele. Moderately severe diffuse headaches lasting several hours were experienced regularly. There was no history of paralysis, paresthesia, dizziness, nor convulsions. Palpitations and shortness of breath had been noted since the age of 10. Her ankles had never been swollen. Since birth numerous small nodules appeared insidiously under her skin and remained permanently as small hard painless swellings which had never become inflamed. The skin always had been darkly pigmented and had numerous *café au lait* areas.

Summary of previous hospital admissions and treatment. Medical aid for her skin lesion was first sought in November 1935 at the age of 4, when she attended the pediatric clinic at the New York Hospital. At this time she was referred to Memorial Hospital because of the tumor growth. Later in 1935 she went to another New York hospital for plastic procedures. These procedures required 2 admissions in 1935 and subsequent admissions in 1941, 1942, and 1947. In 1941 she was noted to have high blood pressure for the first time. Bilateral sympathectomy was done on June 21, 1946 and again on July 1, 1946, for hypertensive symptoms. At this time the arm blood pressure was 200/160 millimeters of mercury. The operation consisted of bilateral excision of the fourth thoracic to the second lumbar ganglia inclusive. In addition, the greater, lesser, and least splanchnic nerves were resected. Examination at that time revealed hypertension of 5 years' duration associated with frequent headaches, seeing spots before her eyes and exertional dyspnea. The positive findings on physical examination were the pachydermatocele, neurofibromas, and brown pigmented spots over the entire body. Cardiac enlargement was observed; a blowing systolic murmur was heard over the entire cor, blood pressure was 200/160 millimeters of mercury and the electrocardiogram was reported abnormal for her age. Diagnosis was neurofibromatosis and hypertensive cardiovascular disease. In 1948 at still another New York hospital 3 more cosmetic procedures were done for removal of the pachydermatocele. In 1948 she was sent to Mount Alto Hospital in Washington, D.C., where an angiocardiogram was reported by Robb. He noted diminished arterial pulsations of the lower extremities and other symptoms suggestive of coarctation. Blood pressure was reported at this time as 186/122 millimeters of mercury in the right arm, 186/118 millimeters of mercury in the left arm, 146/120 milli-

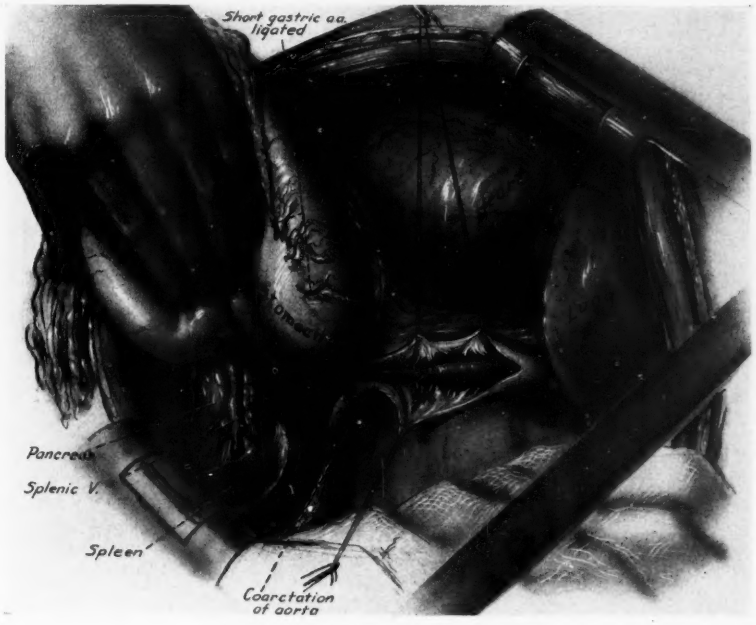


Fig. 5. Operative procedure—next stage.

meters of mercury in the right leg, 148/124 millimeters of mercury in the left leg. Two years later the patient was admitted for the first time to the surgical department of the New York Hospital—Cornell Medical Center.

Physical examination. At that time her temperature was 37 degrees C., pulse 90, respirations 20; blood pressure will be given later in detail. Patient was a well developed and well nourished, small Hebrew female in no acute distress. The positive findings on examination are listed below. The skin color was dark brown. There were numerous, small (0.5 to 1.5 cm.), painless, subcutaneous, hard nodules, irregularly scattered over the body. Similarly scattered over the skin surface were numerous irregular sized and shaped *café au lait* spots. The pachydermatocele consisted of raised and markedly thickened, indurated, uneven dark brown, coarse, elephant-like skin which was devoid of most sensation. The lesion had coalesced into a single tumor which extended over the lower left aspect of the face, ear, neck, and the adjacent areas of the shoulder and chest.

Fundi examination revealed an increased arterial spasm and moderate arteriovenous nicking. The light reflex was increased and the discs were pale and flat. The chest showed no evidence of collateral circulation or pulmonary edema. Examination of the heart showed that moderate cardiac enlargement was present with a blowing systolic murmur heard over the entire precordium as well as posteriorly and in the epigastrium. A systolic bruit but no palpable thrill was present over the left lower posterior thoracic and upper lumbar vertebral regions. This bruit was heard clearly in the epigastrium and over both iliofemoral arterial junctions.

The patient exhibited a moderate degree of right scoliosis and well healed bilateral sympathectomy scars. There was congenital absence of the vagina with only a small vaginal dimple remaining. The external genitalia appeared normal with good development of the vulva, labia majora and minora, clitoris, vestibule and fossa navicularis. Ovaries were palpable bilaterally but the uterus was small and difficult to identify even under anesthesia. Neurological examination revealed that the sensations and all deep reflexes were hyperactive and compatible with minimal pressure effect on the cord because of the scoliosis. Both feet and legs were warm and there were no positional color changes. Bilaterally palpable femoral pulsations were diminished in intensity. Popliteal and posterior tibial arterial pulsations were absent bilaterally. Both dorsalis pedis arterial pulsations were barely palpable. No sweating was observed in either lower extremity. Blood pressures were elevated in the arms and diminished in the legs. The leg oscillometrics were impaired preoperatively. These will be discussed subsequently in comparison with the 12 month postoperative findings.

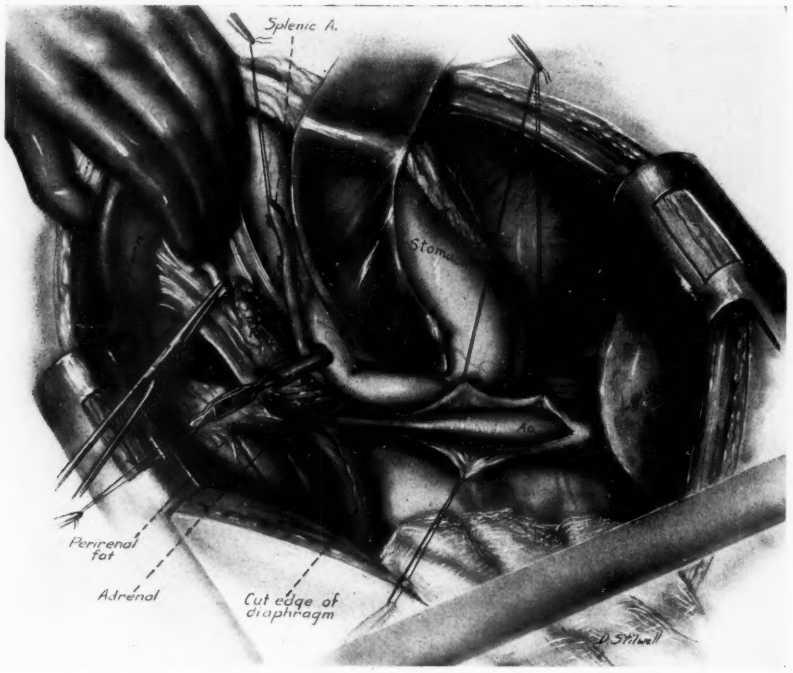


Fig. 6. Operative procedure—preparation of splenic artery for anastomosis.

Laboratory data. Serology was negative. Urinalysis and complete blood count were not remarkable. Blood chemistries were within the normal range with a blood urea nitrogen of 11 milligrams per cent. Electrocardiogram revealed minimal pathological changes with slight irregularities in rhythm and ventricular hypertrophy. Roentgenogram of the chest showed no rib notching nor evidence of collateral circulation. Roentgenograms of the skull and bony skeleton indicated a mid-dorsolumbar scoliosis to the right and no evidence of the bone changes as seen in von Recklinghausen's disease.

Arteriography. The angiocardiogram (Fig. 1) showed a fusiform narrowing of the lower thoracic and proximal abdominal aorta from the mid-portion of the tenth thoracic to the first lumbar vertebra. The overall length of the coarctation was estimated to be 10.5 centimeters, the diameter 0.5 centimeter. Evidence of collateral circulation was present. Since the inferior segment of narrowing was not well demonstrated, a retrograde aortogram was done. In performing this examination, a polythene tube was passed via the right femoral artery to the level of the constriction and withdrawn slightly (to the level of the renal arteries). Diodrast was then rapidly injected and multiple films of the abdomen taken. These showed that the distal portion of the constriction involved the celiac axis (Fig. 2). A berry aneurysm of the right renal artery was present. Immediately following the aortogram the blood pressure fell to unobtainable levels. With the use of neosynephrine the pressure could again be obtained and was maintained during the succeeding day with methoxamine hydrochloride. Oliguria appeared and the blood urea nitrogen gradually rose to 64 milligrams per cent with 4 plus albuminuria. Complete recovery of renal function ensued with the blood urea nitrogen returning to 15 milligrams per cent. There persisted evidence of thrombotic occlusion of the right femoral artery at the site of insertion of the polythene tube.

Preoperative diagnosis consisted of (1) coarctation of distal thoracic and proximal abdominal aorta, partially involving the celiac axis; (2) berry aneurysm of right renal artery; (3) von Recklinghausen's disease with multiple neurofibromas and scoliosis (no osteitis fibrosa cystica as seen in von Recklinghausen's disease); (4) congenital absence of vagina, and hypoplasia of the uterus.

OPERATION

Under endotracheal cyclopropane anesthesia a left thoracoabdominal incision was made and the ninth rib resected (Figs. 3 and 4). The left diaphragm was incised from the costal at-

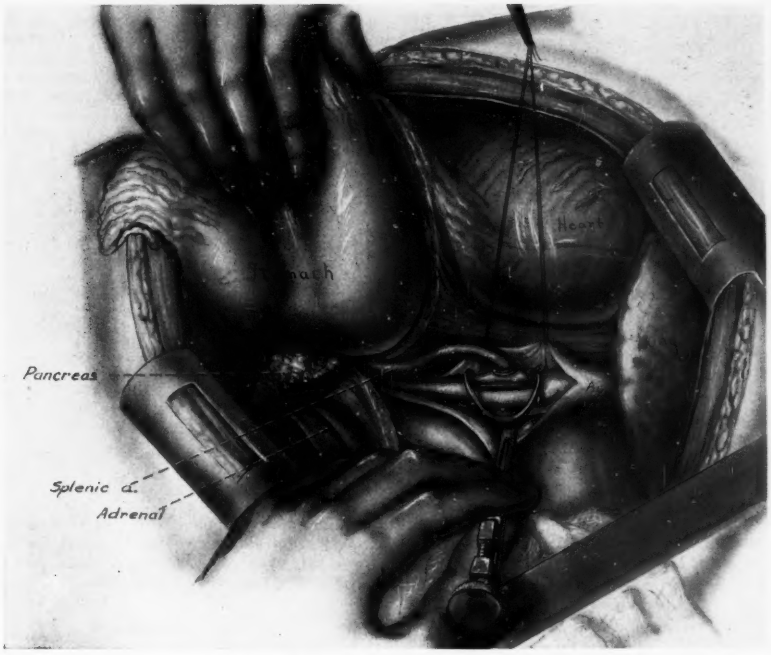


Fig. 7. Operative procedure—final stage.

tachment to the aperture through which the aorta passed. A large collateral artery in the diaphragm was spared. The spleen was excised and the splenic artery prepared (Figs. 5 and 6) for anastomosis with the thoracic aorta. In dissecting the proximal portion of the coarctation a cuff of adherent fibrotic tissue surrounding the aorta was encountered. This tissue was sent to the pathologist who reported it as fibrous and nerve tissue, with a diagnosis of neurofibroma. The constricted area measured approximately 10 to 12 centimeters in length and 0.8 centimeter in outside diameter. The distal portion was not visualized but could be felt to enter the region of the celiac axis and its regional viscera. A strong thrill could be felt in this area and transmitted along the renal and mesenteric vessels. The proximal aorta was now dissected free without division of the intercostals. A Potts clamp was placed around it (Fig. 7) and an end-to-side anastomosis performed between the splenic artery and the proximal thoracic aorta. On completion of this anastomosis the splenic artery was observed to distend normally and a good thrill was palpable. The diaphragm was approximated except in the area of splenic artery penetration, which was immediately adjacent to the aortic hiatus.

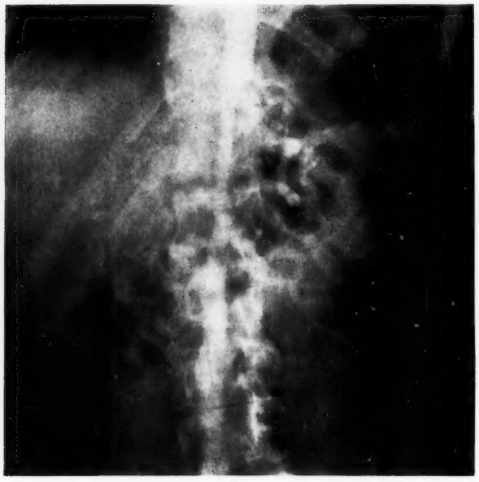
COMPARISON OF PREOPERATIVE AND POSTOPERATIVE VASCULAR STUDIES

Blood pressure: Preoperative

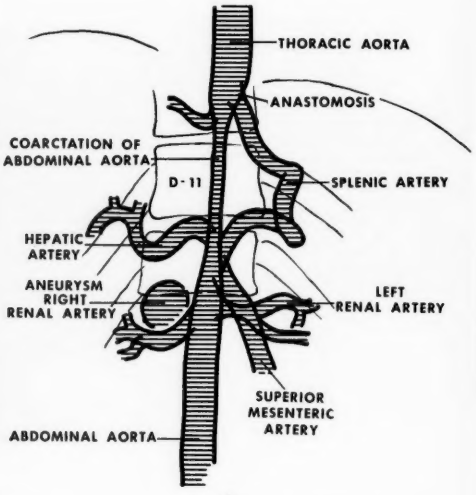
1. Prior to sympathectomy:
   1941 arm pressure 220/175
   1946 arm pressure 200/160
2. Postsympathectomy: 1948 (16)
   Left arm 186/118 Right arm 186/122
   Left leg 148/124 Right leg 146/120
3. New York Hospital—Cornell Medical Center—1950
   a. Maximum on admission:
      Left arm 230/120 Right arm 235/120
      Left leg 152/120 Right leg 150/115
   b. Minimum after hospital bed rest:
      Left arm 178/120 Right arm 170/120
      Left leg 152/114 Right leg 150/116

Blood pressure: 12 months postoperative, patient ambulatory and attending school

Left arm 138/90 Right arm 140/88
Left leg 140/100 Right leg not obtainable (Thrombosed femoral artery—Fig. 2)



A



B

Fig. 8. A, Postoperative retrograde aortogram with catheter inserted through left brachial artery and passed into descending aortic arch distal to left subclavian orifice. Initial roentgenograms taken at ½ second intervals show contrast material filling both abdominal aorta and splenic artery from above downward and at approximately the same rate of flow. B, Tracing demonstrates the aorta and splenic artery as seen in aortogram.

Oscillometrics: Preoperative

	Left leg	Right leg
Thigh	0.5 units	0 units
Mid calf	1.5 units	0 units
Dorsum foot	0.0 units	0 units

Oscillometrics: 12 months postoperative

	Left leg	Right leg
Thigh	2.0 units	1.0 units
Mid calf	4.5 units	2.0 units
Dorsum foot	1.0 units	0.5 units

Present status. Clinically the patient shows definite improvement and has noted a general alleviation of her symptoms. She feels better and does not tire as easily. She does not experience the preoperative intermittent claudication. Preoperative and postoperative x-ray visualizations of the lesion (Figs. 1, 2, and 8) by contrast substances indicate very accurately the respective pathology and physiology encountered at operation. A serial postoperative aortogram (Fig. 8) done by inserting a catheter into the left brachial artery to the level of the descending aortic arch demonstrates the blood flowing out the aortosplenic anastomosis in chest and returning through the splenoceliac junction, since it fills from above downward. Accurate arteriographic composite studies are diagrammed (Fig. 3).

SUMMARY

An unusual coarctation of the lower thoracic and abdominal aorta is presented. This lesion was successfully repaired with gratifying results. We believe that this is the first time this operative procedure has been employed (Figs. 3 to 7 inclusive).

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RECONSTRUCTION OF THE TRACHEOBRONCHIAL TREE WITH RESECTION OF THE LUNG, CARINA, AND LOWER TRACHEA

An Experimental Study

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THERE have recently appeared in the surgical literature several experimental studies of healing, regeneration, and reconstruction of the tracheobronchial tree. The impetus to this work is twofold. First, it is desirable to preserve normal lung parenchyma which lies distal to a benign resectable bronchial lesion. Second, the present surgical treatment of bronchogenic carcinoma with local metastases and carinal involvement is inadequate. A reconstructive procedure involving an anastomosis between the distal divided end of the normal bronchus and the upper lateral wall of the trachea with subsequent resection of the involved lung, carina, lower trachea, and regional lymphatics in an en bloc dissection might well extend the limits of resectability in dealing with lesions at or near the tracheal bifurcation. The present study was undertaken to determine the feasibility of such a reconstructive procedure and resection.

Taffel, Daniel, Longmire, and others (2) have made observations concerning the repair of tracheal and bronchial defects produced experimentally in animals. A defect of this type is replaced by scar tissue within which imperfect cartilaginous rings eventually form. Epithelialization takes place about the periphery of the defect and is apparent within 2 weeks. Polythene tubes (6) and other supportive structures have been used in the repair of tracheal defects, but the results have been unsatisfactory. An anastomosis without the use of supporting tubes is preferred. Jackson and associates found that an everting anastomosis is the most satisfactory method of reconstructing a divided bronchus. Grindlay, Clagett, and Moersch (6) and more recently Ferguson, Wild, and Wangensteen have published similar methods for end-to-end bronchotracheal anastomosis with successful resection of the lung, main bronchus, and carina in dogs. In a previous article (10) we described a method of performing a bronchotracheal anastomosis between a bronchus of a lobe of the lung and the lateral wall of the trachea 3 to 5 centimeters above the carina, and we reported the functional capacity and fate of the transposed lung tissue. This paper is devoted to the technique, results, and clinical possibilities of transposing a main bronchus to the lateral wall of the trachea with subsequent resection of the opposite lung, carina, lower trachea, and regional lymphatics.

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METHODS

The animals used in this experiment were divided into three groups. In group I, a series of 6 dogs, an everting anastomosis was made between the distal divided end of the right main bronchus and the lateral wall of the trachea 4 to 6 centimeters above the tracheal bifurcation. In these animals the vagal branches to the transposed right lung were preserved. Dogs weighing 10 to 22 kilograms were anesthetized with intravenous pentobarbital sodium and atropine. An endotracheal tube with an inflatable cuff was introduced into the trachea and attached to a resuscitator. A positive pressure of 10 to 15 centi-

meters of water was maintained during the operative procedure. A posterolateral incision was made over the right fourth interspace and carried through the chest wall. The inferior pulmonary ligament was divided and the right lung was retracted ventrally. The mediastinal pleura overlying the trachea was incised, and the azygous vein was isolated, divided, and ligated. The pleura overlying the hilum was dissected away, exposing the carina and right main bronchus (Fig. 1). This bronchus was isolated, and the bronchial arterial supply to the right lung was severed. The right vagus nerve was isolated, and the vagal fibers to the posterior pulmonary plexus and right lung were preserved. The right main bronchus was divided near the trachea. The proximal bronchial stump was closed with two layers of No. 000 silk. Further mobilization of the right lung on its vascular pedicle was obtained by stripping away fascial and pleural coverings overlying the pulmonary vessels. This procedure allowed the distal divided end of the right main bronchus to be brought 4 to 6 centimeters above the tracheal bifurcation up to the right lateral wall of the trachea without tension. A circular stoma 1.0 to 1.4 centimeters in diameter was made on the right lateral wall of the trachea 4 to 6 centimeters above the carina. During the time that this tracheal stoma was open, it was occluded digitally for 60 seconds of each 90 second interval to allow adequate aeration of the left lung. Four interrupted No. 000 silk mattress sutures were placed at positions of 3, 6, 9, and 12 o'clock on the right lateral wall of the trachea. Each stitch was taken from outside to inside through the distal divided right main bronchus 1 to 2 millimeters from the edge of the bronchus then through the tracheal wall about 2 millimeters from the edge of the stoma from outside to inside and returned through these structures in the reverse order (Fig. 2). After the four sutures were placed they were tied, and the orifice of the right main bronchus was brought in approximation to the tracheal wall over the new stoma. The wall of the distal divided right main bronchus then formed an everting cuff around this stoma. This was an everting bronchotracheal anastomosis (Fig. 3). A running No. 000 chromic surgical catgut suture was taken around the periphery of the anastomosis between the everted edge of the right main bronchus and the outer fibrocartilaginous layer of the trachea. This rendered the anastomosis airtight. The mediastinal pleura was closed over the operative site (Fig. 4), and the transposed lung was re-expanded under

Fig. 1. The right hilar region after dissection of the mediastinal pleura and connective tissue. The azygous vein has been divided and ligated. The right lung has been retracted ventrally. The right vagus nerve courses caudally from left to right over the right lateral wall of the trachea (*A*). Vagal branches (*B*) to the right lung are given off at the tracheal bifurcation and lie on the dorsal aspect of the right main bronchus (*C*). Bronchial arteries (*D*) to the right lung traverse the dorsal inferior aspect of the right main bronchus.

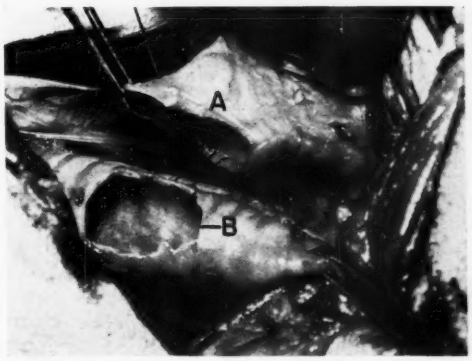

Fig. 2. The right hilar region after creation of a tracheal stoma (*B*) 5 centimeters above the carina on the right lateral wall of the trachea. One interrupted horizontal mattress suture has been placed on the ventral aspect of the tracheal stoma and divided right main bronchus (*A*). This is to be an everting anastomosis. The closed bronchial stump lies distal to the forceps at *C*.

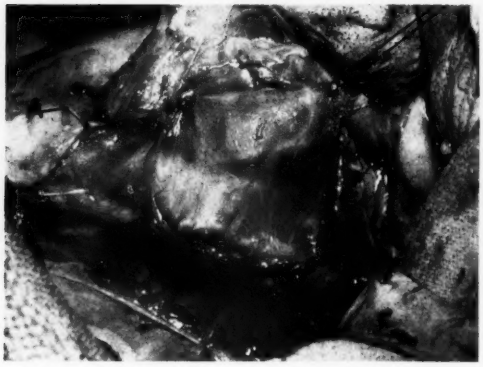

Fig. 3. Everting anastomosis completed (*A*). Proximal closed right bronchial stump on right side of illustration (*B*). Entire right bronchial arterial supply has been severed.

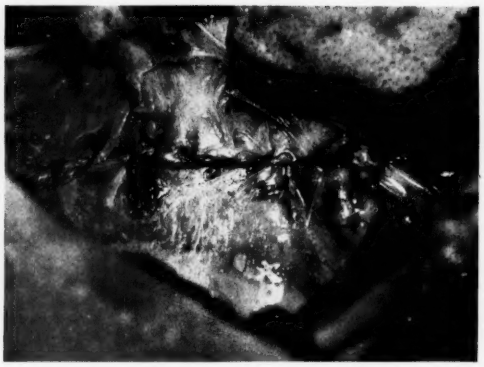

Fig. 4. The operative site has been repleuralized. The right lung, seen on the upper part of the illustration, has already begun to re-expand.

increased positive pressure (20 to 30 cm. water). The chest wall was closed by layers. A catheter (No. 22 French) was left in the right pleural space during the first postoperative hour.

Contralateral pneumonectomy with resection of the carina was performed 1 to 3 weeks after the original operative procedure.

In group II, a series of 6 dogs, the same operative procedure was performed, except that all vagal fibers to the transposed right lung were divided. Contralateral pneumonectomy with resection of the carina, lower trachea, and hilar lymphatics was carried out 1 to 3 weeks after the original operative procedure on animals in group II.

In group III, a series of 4 dogs, a right bronchotracheal anastomosis was performed through a right thoracotomy incision. The chest wall was closed, and the animal was turned to the left lateral recumbent position. A left thoracotomy was performed and the lung, carina, lower trachea, and regional lymphatics were resected. The left phrenic nerve was crushed, and the left chest was closed without drainage. This was a combined one stage procedure.

Preoperative and postoperative studies of the arterial oxygen saturation by the method of Van Slyke and Neil were carried out. Those animals that died postoperatively were studied grossly and microscopically to determine the cause of death. Bronchoscopic, fluoroscopic, and, in some instances, lipiodol studies were carried out on dogs surviving the surgical procedure. The animals were sacrificed 2 to 8 months after the bronchotracheal anastomosis. Gross and microscopic examinations were made of the transposed lung, bronchus, trachea, and anastomotic site.

RESULTS

Group I. Vagal fibers to transposed right lung preserved. There were no operative fatalities in this series of 6 dogs. Five animals survived both operative procedures and were sacrificed 2 to 8 months later. One animal died 6 hours after the second operative procedure because of diffuse interstitial pneumonitis involving the entire right lung. The right upper lobe was partially atelectatic. These pathological findings were secondary to narrowing of the tracheobronchial stoma.

Group II. Vagal fibers to transposed right lung transected. Five of the 6 animals in this series survived both operative procedures and were sacrificed 2 to 6 months later. One animal died 30 minutes after the second operative procedure. At autopsy an extensive pneumonia of the right lung was found. There were thick secretions within the bronchus and trachea. The preoperative, postoperative, and autopsy findings are summarized in Table I.

Group III. Combined one stage procedure. In this series of 4 dogs none survived the operative procedure for longer than 48 hours. One

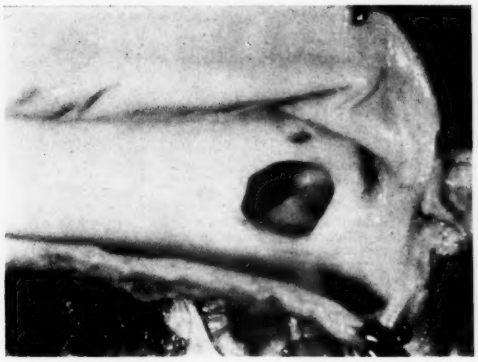

Fig. 5. The bronchotracheal anastomosis in dog 34 viewed at its site of entrance into the lateral wall of the trachea. The trachea has been opened anteriorly and its left wall reflected laterally. The lower trachea, carina, left main bronchus, left lung and hilar lymphatics were resected 6 months before the animal was sacrificed. The stoma has a smooth epithelialized border.

Fig. 6. A coronal section through the right lung of dog 34 shows no evidence of pathological change. The anastomotic site and closed tracheal stump are well healed.

dog died 6 hours following surgery from a tension pneumothorax and atelectasis. Two dogs died 24 and 28 hours after surgery. Both animals were in shock at the conclusion of the operative procedure. The fourth animal died 48 hours after surgery. At autopsy the mediastinum had shifted to the right, and the right lung was partially atelectatic. The anastomosis was patent in all animals.

Illustrations are given of a successful transposition of the right lung and subsequent left pneumonectomy and carinal resection. This animal (dog 34) was sacrificed 6 months after the second stage procedure. The anastomotic site is patent (Figs. 5 and 6). A coronal section (Fig. 6) through the anastomotic site and transposed right lung grossly shows no pathologic change. Microscopic section (Fig. 7) through anastomotic site shows complete re-epithelialization over minimal granulation tissue.

DISCUSSION

Because it is desirable to preserve normal lung tissue distal to a benign bronchial lesion and because the present treatment of bronchogenic carcinoma with carinal involvement is inadequate, it would be desirable to develop reconstructive procedures which would allow subsequent resection of the tracheal bifurcation. We feel that an end-to-side bronchotracheal anastomosis offers advantages over an end-to-end reconstruction and has a wider range of applicability. The problem of anastomosis between rigid structures of lumen size is simplified, and the transposed bronchus comes off the trachea at a more normal angle. An everting anastomosis is technically easier to do and, as has been shown, heals with much less stenosis than the inverting type.

Adequate mobilization of the transposed lung on its vascular pedicle is essential so that no tension is present at the anastomotic site. This is achieved by stripping the pleural and fascial coverings over the pulmonary vessels.

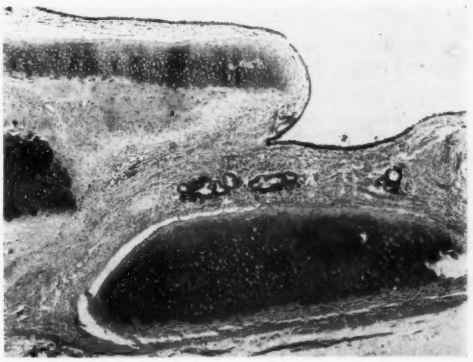

Fig. 7. Photomicrograph was made of a radial section through the healed bronchotracheal anastomosis from dog 34. There is minimal granulation and fibrous tissue between the joined trachea and bronchus. Epithelium covers the surface of the anastomotic site.

TABLE I.—RESULTS OF PREOPERATIVE AND POSTOPERATIVE STUDIES OF DOGS IN GROUPS I AND II

	Studies following right bronchotracheal anastomosis				Studies following left pneumonectomy and carinal resection		
Animal No.	Roentgenologic	Bronchoscopic	Left pneumonectomy and carinal resection, weeks	Preservation of vagal branches to right lung	Roentgenologic	Bronchoscopic	Survival following left pneumonectomy and carinal resection
30	None	Examination 1 and 2 weeks. Stoma patent	3½	No	Slight mediastinal shift to left. Rt. lung well aerated—1 mo.	Stoma widely patent. Stump well healed at 2 mos.	Sacrificed 2 mos.
31	No mediastinal shift. Rt. and lt. lungs well aerated—2 wks.	Examination 2 weeks—stoma patent but narrowed. Thin secretion from stoma aspirated	3	Yes	None	None	Died 6 hrs. postoperatively
32	Rt. and lt. lungs well aerated. No mediastinal shift—2½ weeks	Examination 2½ weeks—stoma widely patent	2½	No	Mediastinal shift to lt. side. Lt. diaphragm elevated—1 mo. Shift less marked at 2 mos.	Stoma patent and epithelialized. Stump well healed—3 mos.	Sacrificed 5½ mos.
33	Both lung fields well aerated	None	3	No	None	None	Died ½ hr. postoperatively
34	1 week—lung fields appear normal	Stoma widely patent—1 week	2½	Yes	Rt. lung well aerated. Lt. pleural effusion	Stoma patent—3 mos.	Sacrificed—6 mos.
35	None	Stoma widely patent—2 weeks	2	Yes	Both lung fields well aerated	None	Sacrificed—5 mos.
36	None	Examination 1 week—stoma patent	1½	Yes	Both lung fields well aerated. Lt. diaphragm elevated	Examination 6 weeks: Stoma widely patent. Tracheal stump healed	Sacrificed—2 mos.
37	No mediastinal shift. Rt. and lt. lung fields clear	None	2½	No	None	Examination 2 mos. Stoma patent	Sacrificed—6 mos.
39	Both lung fields clear	Examination 3 weeks: Stoma widely patent and well epithelialized	4	Yes	Marked left mediastinal shift for 2 weeks. Less marked shift present at 3 mos.	Examination at 2 mos. Stoma widely patent. Trachea well healed	Sacrificed—8 mos.
40	None	None	2	Yes	None	Examination at 2 and 3 mos. Stoma patent	Sacrificed—4½mos.
41	Both lung fields clear	Stoma widely patent—3 weeks	3	No	Both lung fields clear	Stoma patent 2 mos.	Sacrificed—5 mos.
42	None	Examination 2 weeks: Stoma patent	3	No	Both lung fields clear	Stoma patent but somewhat narrowed	Sacrificed—2 mos.

Ligation of the bronchial arterial supply to the transposed lung can be carried out with impunity. The bronchial arterial supply has repeatedly been ligated experimentally without evidence of pulmonary necrosis or infarction, nor does this procedure appear to change to any constant or significant degree the percentage of arterial oxygen saturation. Infarcts produced in lung tissue deprived of its bronchial arterial supply by surgical ligation of a secondary arterial branch to a lobe are similar to the same type of infarct produced when the bronchial arterial supply is intact (9).

In a previous paper (10) we reported 6 dogs which survived for only a limited time after right bronchotracheal anastomosis and subse-

TABLE I.—RESULTS OF PREOPERATIVE AND POSTOPERATIVE STUDIES OF DOGS IN GROUPS I AND II—Continued

Percentage arterial oxygen saturation			Size of stoma, mm.		Autopsy findings					
Before surgery	After Broncho-tracheal anastomosis	After lung carinal resection	Initial	Final	Pleuritis	Pneumonitis	Atelectasis	Epithelialization of stoma	Other developments	Result
97.8	98.9	97.0	12.0	8.5	Fibrous	None	None	Yes	Left diaphragm elevated. Mediastinum shifted somewhat to left side. Operative sites well pleuralized and healed	Good
98.1	95.6 and 87.8	—	11.0	4.0	Fibroserous with effusion.	Mild interstitial	Partial of Rt. upper lobe	Yes	Narrowed stoma with secondary pathological findings in rt. lung. Profuse bronchial secretions	Died
95.2	93.4	92.0	11.0	9.0	Minimal fibrous	None	None	Yes	Operative sites well healed. Lt. mediastinal shift less marked than immediately postoperatively	Good
97.8	92.0 and 88.7	—	10.5	8.0	Fibrinous with serosanguinous effusion.	Extensive rt. lung	Partial	Yes	Had distemper 2 mos. previously. Profuse thick secretions in trachea and bronchi	Died
91.8	90.0	94.0	13.0	11.5	None	None	None	Yes	Mediastinum not shifted	Good
96.1	90.5	86.6	11.5	10.0	Fibrous	None	None	Yes	Lt. mediastinal shift. Esophagus dilated. Heart not enlarged	Fair
98.8	96.5	88.9	14.5	12.0	Minimal fibrous	None	None	Yes	No explanation found for animal's postoperative nystagmus and ataxia	Good
99.4	—	93.6	15.0	12.5	Fibrous	None	None	Yes	No mediastinal shift. Operative sites well healed	Good
97.4	92.8	93.0	12.0	9.5	Minimal fibrous	None	None	Yes	No mediastinal shift present at autopsy	Good
—	—	94.0	13.0	6.5	Fibrous	None	None	Yes	Stoma somewhat more narrowed than usual but transposed lung tissue appeared normal	Good
99.2	94.6	94.8	12.0	10.0	Fibrous	None	None	Yes	No mediastinal shift. Lt. diaphragm elevated	Good
98.0	87.1	89.2	11.0	6.0	Fibrous	Diffuse mild interstitial	Partial of right upper lobe	Yes	Stoma narrowed but transposed lung was able to sustain function. Animal lost weight postoperatively	Fair

quent left pneumonectomy. At that time it was postulated that this failure was due to division of vagal fibers to the transposed lung and consequent suppression or obliteration of the cough reflex, postoperatively. It is clear from the results in groups I and II, however, that preservation of these fibers is not essential and does not influence the survival of the animal. Preservation or division of these fibers also does not appear to influence postoperative mediastinal shift which was observed in 4 dogs. This mediastinal shift was most marked in the 2 to 3 weeks immediately following the second operative procedure. In 1 instance this shift was severe enough to cause partial esophageal obstruction at the level of the

diaphragm. Left phrenic nerve crush and postoperative regulation of the pressure in the left pleural space are effective in preventing and correcting this disorder.

Although a combined one stage procedure has been used on 4 dogs with very limited success, it is believed that a two stage procedure is the more reliable and will prove the more widely applicable in man. We have used the two stage procedure in 1 human case in which a bronchogenic carcinoma, originating in the left main bronchus, also involved the carina. The combined one stage procedure requires a considerably longer operative period and necessitates turning the animal during the second stage so that the right side is in a dependent position. It may be expected that this combination of factors would lead to greater alterations in pulmonary physiology during the immediate postoperative period and hence to an increased operative mortality. This aspect of the problem will require further investigation and study.

SUMMARY

The right main bronchus has been successfully transposed to the lateral wall of the trachea with subsequent resection of the left lung, carina, lower trachea, and hilar lymphatics in 10 out of 12 dogs. The type of anesthesia and the operative technique are described. Factors influencing the type and healing of the bronchotracheal anastomosis are considered.

Postoperative physiologic studies including arterial oxygen saturation, bronchoscopic examination, and bronchograms were essentially normal. The animals were all allowed to live from 2 to 8 months on only the transposed lung and were then sacrificed. Gross and microscopic examination of the anastomotic site and the transposed lung showed no abnormalities.

Ligation of the entire bronchial arterial supply to a lung does not alter the structure, function, or impair the viability of the lung. Preservation of the vagal branches to a transposed lung is not essential.

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WOUND HEALING: HEAT TURBIDITY INDEX AND METHYLENE BLUE REDUCTION TIME OF PLASMA

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THE physiology of and the stimulus to wound healing are as yet incompletely understood. In an attempt to understand this process further, it was noted that similar changes occur in plasma proteins in patients with cancer and in patients during the course of wound healing. Recent studies on wound healing by Cole and Shaw have shown that following operation and during wound healing there is a rise in serum hyaluronidase inhibitor. Hakanson and Glick (7) have shown that serum hyaluronidase inhibitor is increased 52 to 140 per cent in patients with cancer.

Within the past few years a number of blood tests have been proposed for the detection of cancer based on alterations of blood proteins. One such test was proposed by Black, Kleiner, and Bolker (11) in 1947 to 1948, consisting of the parallel determinations of the methylene blue reduction time and the heat turbidity index of plasma. The heat turbidity index appears to measure changes in fibrinogen level, since the test is operative when plasma is used and not operative when serum is used (7). Ham and Curtis (8) have found fibrinogen concentration in the plasma of man to remain relatively constant in normal individuals. The methylene blue reduction time measures the reducing power of plasma, which is believed due to the presence of S or SH (2), (7). Kleiner and associates (11), in a series of 500 cases, report that 95.4 per cent of patients with cancer have abnormal plasma proteins by these tests. However, it is known that these tests are not specific for cancer and following is a list of conditions known to give abnormal tests: tuberculosis, acute rheumatic fever, pregnancy, osteomyelitis, gastric ulcer, colitis, psoriasis, von Recklinghausen's disease, fibromyomas of the uterus, and a plasma protein level below 5 milligrams per cent (12). It was decided to utilize these tests to study the blood proteins during the course of wound healing.

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METHOD

Experimental observations were carried out on the plasma obtained from 9 male patients on the surgical service of the Cleveland Veterans Administration Hospital. The ages of the patients varied from 20 to 43 years. All patients were admitted to the hospital only for the repair of inguinal hernias. All patients had normal roentgenograms of the chest. Complete histories and physical examinations were normal, except for the hernias present, in all but 2 cases. One patient had hemorrhoids, and observations were made including both postoperative intervals; the other patient gave a history of bronchial asthma. Fasting blood specimens (10 c.c., oxalated) were obtained daily beginning 1 to 3 days preoperatively and continuing postoperatively until the patients were discharged (seventh to tenth day). The operative procedures were performed without complication under spinal anesthesia. There were no wound complications and the sutures were removed on the sixth to seventh postoperative day. Ambulation was begun approximately 24 hours postoperatively with the exception of the patient with the history of asthma. This patient developed bronchitis postoperatively (chest roentgenogram was normal) and was treated with penicillin for several days. The oxalated blood specimens were centrifuged (3,000 revolutions per minute for 20 minutes) and the plasma was pipetted off into test tubes, corked and stored in a deep freeze unit at 0 to −4 degrees F. The tests were run on several duplicate samples immediately before freezing and

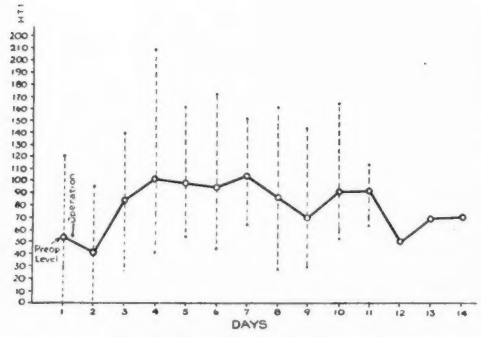

Chart 1. Heat turbidity index: composite of 10 patients operated upon showing mean deviation.

6 weeks later; the results were essentially the same. Thus once the plasma was separated and frozen the tests could be done at a later date. When the tests were done the frozen specimens were placed in a test tube rack at room temperature until the contents were fluid.

Methylene blue reduction time. To 1 milliliter of plasma in a Wassermann tube is added 0.2 milliliter of a standardized solution of methylene blue in distilled water (150 mgm. of dye per 100 ml. of solution). One drop of capryl alcohol is added to prevent foaming. The tube is then placed in a beaker of briskly boiling water. The time of disappearance of the last trace of color is recorded to the nearest half minute without removing the tube from the boiling water (dye regains color on slight cooling).

Heat turbidity index. To 1 milliliter of plasma in a colorimeter tube 4 milliliters of distilled water is added and mixed. The tube is then placed in a Coleman spectrophotometer and a reading is recorded. The tube is then placed in a bath of briskly boiling water of sufficient height to cover 9/10 of the tube (i.e. to cover the level of diluted plasma). Using a stopwatch, the tube is held in place for exactly 10 seconds and immediately removed and cooled for 30 seconds under cold running water. The tube is dried, the contents mixed, and the tube is then placed in the spectrophotometer and a reading again recorded. The readings as described by the originator of this test were taken with a Klett colorimeter using a 540 millimeter filter (11). A Klett colorimeter was not available thus the readings were recorded with a Coleman spectrophotometer set at a wave length of 600 microns and then expressed as Klett readings by the formula:

$$\text{Klett reading} = \frac{94.53 \text{ minus per cent transmission}}{0.197}$$

The difference between the readings before and after heating, each converted to Klett readings, is the heat turbidity index (11).

RESULTS

Heat turbidity index and methylene blue reduction time tests were run on plasma from 9 patients during the preoperative and postoperative phases of 10 operations. Following surgery all patients showed a sudden marked rise in the heat turbidity index (Chart 1) which reached a maximum between the second and fifth postoperative day. In the first 24 hours after operation 7 patients presented an initial drop of the heat turbidity index. Following the rise of the heat turbidity index between the second and the fifth day, it fell slowly to approximately the preoperative level on the twelfth to fourteenth postoperative day. The composite graph (Chart 1) shows the postoperative rise of the heat turbidity index to be approximately 100 per cent over the preoperative level.

The methylene blue reduction time did not follow as definite a pattern as the heat turbidity index. As shown by the composite graph (Chart 2) there is a slow postoperative rise of the methylene blue reduction time with an apparent peak on the 13th postoperative day following which it tended to return toward normal.

One patient had a herniorrhaphy and 1 week later a hemorrhoidectomy. This patient showed following the first operation the typical response of the heat turbidity index and methylene blue reduction time. The index dropped in the first 24 hours postoperatively and then there was a marked rise reaching a maximum on the third postoperative day. Following this peak the index dropped gradually and had not returned to normal by the seventh day, at which time the hemorrhoidec-

tomy was performed. Following this procedure the heat turbidity index continued to fall for 24 hours and then rose to a maximum on the third postoperative day; this maximum was even higher than that following the herniorrhaphy. This tended to show an additive effect on the heat turbidity index during the second wound healing period. Work is in progress to substantiate this finding. The methylene blue reduction time began to rise just prior to the second operation, the rise continued through to the fourth postoperative day (following the second operation) then rose again rapidly after the seventh postoperative day.

These experiments on normal patients show that operative trauma and subsequent wound healing produce alterations of the blood plasma. The heat turbidity index and methylene blue reduction time tests are not known to be specific for fibrinogen and the S of SH radicals, although there is evidence to suggest that they may be. If it is assumed that the heat turbidity index is a measure of the fibrinogen, and that the methylene blue reduction time is a measure of S of SH radicals, the results of these tests suggest the following interpretations.

The results of the heat turbidity index tests suggest, if Huggins' postulate is substantiated, that the plasma fibrinogen levels are lowered during the first 24 hour period after the trauma of surgery and that within 48 hours the stimulus of trauma and wound healing initiates a definite rise of plasma fibrinogen, which slowly returns to normal within 2 weeks. Cuthbertson (4) found that the fibrinogen fraction of plasma was often appreciably raised during the catabolic phase of protein metabolism which follows trauma. He (5) believed that the changes which occur after trauma were the result of the organism's catabolizing its reserves to meet the exigencies of the repair. The reduced fibrinogen plasma levels immediately postoperatively may be due to loss through the surgical wound or mobilization at the site of trauma and also to the formation of fibrin framework in the incision along which the fibroblasts and capillaries grow. According to Ham and Curtis (10) fibrinogen is produced by the liver and

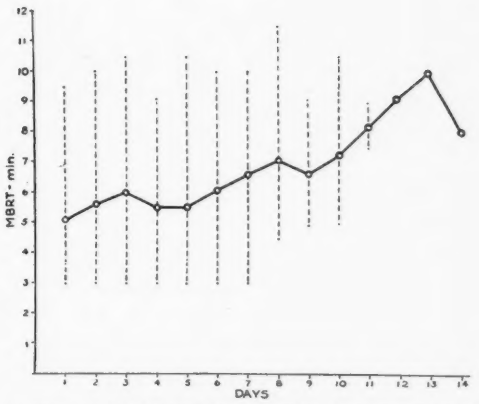

Chart 2. Methylene blue reduction time: composite of 10 patients operated upon showing mean deviation.

thus the initial reduction in fibrinogen may be the stimulus to the liver for the increased production of fibrinogen. However, the postoperative rise in plasma fibrinogen may not be due to its increased production but rather to a rise secondary to changes in tissue permeability due to the surgical stress.

The increased fibrinogen levels following surgical trauma, and the additive effect of the fibrinogen level by secondary trauma may be a factor in the increased tensile strength and increased healing rate of secondary wounds which was observed by Young, Fisher, and Young and by Sandblom. It is possible that the increased fibrinogen level may increase the fibrin network in a wound either in quality or quantity and thus augment the wound healing process.

That the methylene blue reduction time is in any way a measure of plasma SH radicals seems highly speculative; the experimental evidence for this is extremely meager. For mere speculation we offer the suggestion that the slow increase in plasma reducing time, which is believed due to a decrease in the S of SH available, may be due in part to the take up and use of these radicals by the young, growing fibroblasts in the secretion of chondroitin sulfate, one of the intercellular cement substances (3). Chondroitin sulfate is believed to help bind collagen fibers together during wound healing. In 1929 Hummett and Reimann (1) concluded from experiments

on plant and animal tissues that the sulfhydryl radical is the essential stimulating agent in cell multiplication. It has been shown by Hinton that the SH radical shortens the lag period of wound healing.

SUMMARY

1. Nine patients were subjected to 10 operative procedures and the effects of this trauma and wound healing were noted by daily determination of the heat turbidity index as well as the methylene blue reduction time of plasma.

2. Assuming that the heat turbidity index is specific for fibrinogen and the methylene blue reduction time test is specific for S or SH then the results of these tests suggest that during the course of wound healing following surgical trauma there may be an initial decrease followed by a rise in fibrinogen level; there may be a concomitant slow decrease in available S or SH of plasma. (a) The plasma fibrinogen peak as evidenced by the heat turbidity index described is apparently between the second and fifth postoperative day. The peak of decreased S or SH as evidenced by the methylene blue reduction time test is on the 13th postoperative day.

3. The possible significance of these findings in relation to wound healing is presented.

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A CONSIDERATION OF THE PRESENT STATUS OF SIMPLE SUTURE IN THE TREATMENT OF ACUTE PERFORATED GASTRODUODENAL ULCERATION

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THIS paper is devoted to a consideration of the results in 219 cases of acute perforated peptic ulcers, which were treated by simple suture at the Beekman-Downtown Hospital, New York, during the years, 1936 to 1950, inclusive. During that 15 year period, only 5 cases were managed by other methods. The purpose of this study primarily is to re-examine this generally favored therapeutic policy, to which our clinic has been so strongly committed. We were prompted to undertake this investigation by the recent advocacy of a nonoperative treatment as the method of therapy to be preferred for acute perforation. Before entertaining the use of this interesting approach, which depends upon the use of intragastric suction and the well recognized supportive measures for its effect, it seemed reasonable to reconsider our therapeutic policy upon the basis of the following factual considerations. We propose first to review our clinic's experience with simple suture and then to compare our results with that method, as it is currently employed, with the factual evidence for the nonoperative treatment, when utilized under comparable conditions.

It is well to state that our approach to this study has been influenced by a certain biometric awareness, which had been impressed upon one of us (S.M.) as a result of his experience with a somewhat similar biometric problem, namely that of evaluating the end results in the surgical treatment of chronic gastroduodenal ulceration. It has not been without good reason that clinicians have almost constantly differed widely concerning the results obtained with the various surgical procedures which had been periodically proposed during the past 3 decades. As we have indicated more fully elsewhere (2), the reason, in our opinion, may be found largely in illogicalities which result from the indifference by clinicians to fundamental biometric considerations which are required for a true evaluation of their clinical experiences. We hope to avoid such illogicalities in this study.

It is quite clear in the light of our present knowledge that the ultimate solution of the problem of acute perforation awaits the finding of a certain method of controlling peptic ulcer activity. Until such a specific cure is developed, treatment of this serious complication should be directed toward counteracting its immediate and subsequent life-threatening effects. The therapy to be preferred is the one which accomplishes these objectives with the least morbidity and lowest mortality. Ultimate results relating to the basic ulcer disease, while important, are of secondary consideration. Accordingly, it is principally upon the basis of the morbidity and mortality results in this series of 219 cases that we propose to appraise our clinic's experience with the use of simple suture.

It has long been evident from empiric experience that the mortality and morbidity results in the treatment of acute perforated peptic ulcer may be influenced by a number of factors. To appraise any experience with a particular therapy presents a somewhat complex biometric problem. In the first place, the mortality and morbidity results must be correlated with the factors which have served to influence them. Otherwise, they have limited significance for comparative considerations. For example, if the nonoperative treatment is to be preferred to simple suture, it must be shown that its morbidity and mortality results are better when employed under comparable conditions, such as may apply with respect to age, general condition, and the dura-

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tion of the perforation. In the second place, it must be recognized that we are confronted with the problem of appraising a therapy, whose inherent effectiveness conceivably might have been significantly modified in the course of the 15 year period with which this study is concerned. While the technical procedure of simple suture basically has remained unchanged, there unquestionably has been steady improvement in the preoperative preparation and postoperative care as a consequence of the periodic adoption of ancillary measures resulting from advances in medical knowledge. In order to appraise the influence of these measures, we propose, whenever indicated, to analyze our data in relation to the following 5 year intervals: 1936 to 1940, 1941 to 1945, 1946 to 1950. The period of 1936 to 1940, which antedates the more significant advances, provides a basis for a comparative evaluation of their effects. The period of 1941 to 1945 was characterized by the introduction of chemotherapy and the more constant use of intragastric suction. The period of 1946 to 1950 was marked by the preferred use of antibiotics, early ambulation, the more alert detection and treatment of phlebitic and pulmonary complications.

It is pertinent to the purpose of this study briefly to indicate the problem of acute perforation, as it has been encountered at our particular clinic. The Beekman-Downtown Hospital, which is situated in the lower end of Manhattan Island, New York, is essentially an emergency institution. It serves an area which includes New York's financial district, a large industrial section, a shipping area with its piers and water-fronts, New York's Chinatown with its oriental population, and the Bowery with its large quota of homeless derelicts and chronic alcoholics. This background of diverse activities accounts for the strikingly varied and contrasting economic, sociological, and physical status of our clinical material. It is also significant that a transient population of 750,000 people enters and leaves the area during the working day, while the permanent resident population numbers only about 40,000 people. This fact plays a major role in influencing the promptness of hospital care in the emergencies arising in our district. The "transient" or nonresident is apt to be brought directly to the hospital by ambulance, while the permanent resident is likely to be delayed at home for variable periods of time. Although our experience at this institution may be considered to be a "select" one, it nevertheless reflects the problem of acute perforated peptic ulcers from most of its varied aspects.

INCIDENCE

The number of cases admitted in each 5 year period was as follows: 1936 to 1940, 50 cases; 1941 to 1945, 70 cases; and 1946 to 1950, 97 cases. An enlargement of our ambulance district in 1944 may account for the increased incidence since that time.

Sex. Only 3 cases of the 219 acute perforated ulcers in this series occurred in female patients.

Age. The age distribution did not vary significantly in the 15 year period covered by this study. Approximately 17 per cent of the cases occurred in patients under 30 years of age, 72 per cent were in the 30 to 59 year age group, and 11 per cent were between 60 to 89 years old. The youngest patient was 17 years of age, and the oldest was 87 years of age.

We found no evidence to indicate that acute perforations tended to occur more frequently in any special occupational group or at any particular season of the year.

Previous history. One hundred and twenty-eight patients gave a story of mild but significant gastric discomfort, while the onset of the acute perforation was claimed to be the first symptom in 30 cases. X-ray studies had confirmed the existence of a peptic ulcer in 32 cases. Eight patients had suffered previous perforations and 21 had had episodes of gross bleeding.

We are inclined to attach much practical significance to the characteristics of the gastric history prior to perforation. In our opinion, the duration and intensity of symptoms frequently portend the nature of the related ulcer pathology, which, as we shall indicate later, may play a significant role in influencing therapeutic results.

Diagnosis. It appears to us that the question of the accuracy of diagnosis assumes more or less practical significance according to

whether or not one treats an acute perforation medically or surgically. While a correct diagnosis, as a rule, is readily made, it is important to remember that such is not always the case. In the presence of acute alcoholism, we have found that a coexisting perforation of a peptic ulcer might not even be suspected. In our recent experience, there were 4 such instances in which the diagnosis was revealed only at postmortem examination. In this series of 219 cases, surgical treatment was delayed significantly in 4 cases because of mistaken diagnoses. Two patients were thought for periods of 18 to 24 hours to be suffering from acute coronary artery occlusions, and the other 2 patients were treated as cases of partial large intestinal obstruction for periods of 24 hours and 48 hours respectively.

To the clinician, who is prepared to explore a so-called surgical abdomen, when suspecting the possibility of an acute perforation, the uncertainty of diagnosis is a matter of secondary importance. This approach makes sure that some other life-threatening condition is not overlooked. We are aware that patients suffering from pneumonia, acute pericarditis, and coronary artery thrombosis have been mistakenly operated upon for acute perforation, but we believe such an error should be extremely rare with modern diagnostic facilities. Actually no such mistake was made in the period covered by this study. This assurance is an important consideration in contemplating the type of treatment to employ for acute perforation.

The two available clinical tests, other than surgery, for confirming a clinical diagnosis are x-ray evidence of free air beneath the diaphragm and the aspiration of gastric contents by abdominal paracentesis. X-ray examination proved to be positive in 60 per cent of the 140 cases in which it was employed. Abdominal paracenteses were performed in 10 cases which were particularly puzzling because of being associated with acute alcoholism. The aspirations were positive in 4 cases.

Some of the advocates of the nonoperative method are willing to regard a well established prior peptic ulcer history, particularly if it has been complicated by bleeding or perforation, to be sufficient evidence per se to establish a diagnosis of acute perforation in a suspected case. It is well to emphasize that this is a rule with potentially serious exceptions. This fact was impressed upon us by a recent case manifesting a classical textbook picture of an acute perforated peptic ulcer. There had been a long standing story of ulcer activity, confirmed by several x-ray studies and by the suture of a previous perforation. Operation revealed a generalized peritonitis resulting from a perforation of an acute diverticulitis of the sigmoid colon. A transverse colostomy was done with an eventual recovery. It might have been unfortunate to have treated this case medically rather than surgically.

Location of perforation. According to the operative descriptions, the sites of perforation were recorded as follows: 102 were in the duodenum with 90 being located on the anterior superior aspect and 9 on the posterior part of the first portion; 3 perforations occurred in the second part of the duodenum; 116 were considered to be gastric ulcers, of which 108 were in the anterior prepyloric region, and 8 were situated on the lesser curvature at the re-entrant angle; there was 1 perforation of an anastomotic ulcer, which had developed after a previous subtotal gastrectomy; there were no instances of multiple perforations.

Pathology. In general, the perforations which occurred in the cases without any particular significant prior digestive trouble were of the classical "punched out" type. They varied from 1 to 7.5 millimeters in size and were situated either in the free anterior or anterosuperior aspect of the duodenum or stomach. When the perforation was particularly small, it was not unusual to observe a concomitant walling-off process sufficient to anticipate a spontaneous closure. Despite varying degrees of surrounding edema and induration, as a rule, these perforations of a suggestively acute ulceration presented little technical difficulty in closure. A somewhat different pathology was noted in many of the patients with long standing symptoms of peptic ulceration complicated by bleeding and intractable pain. As a rule, they disclosed chronic calloused posterior duodenal or lesser curvature gastric ulcers penetrating against the pancreas. The site of perforation occurred at an unwalled-off ante-

TABLE I.—POSTOPERATIVE COMPLICATIONS

Years	No. cases 1936–1950	No. cases 1936–1940	No. cases 1941–1945	No. cases 1946–1950
Total No. of cases	219	52	70	97
Pneumonia	19	6	7	6
Wound infections	33	13	11	9
Subphrenic abscess	2	0	1	1
Fistulas, duodenal or gastric	3	1	1	1
Pelvic abscess	4	1	1	2
Gastric hemorrhage	1	0	0	1
Wound dehiscence	10	2	7	1

rior edge or from an adjacent more anteriorly placed so-called "kissing ulcer." These perforations originating from a chronic posterior wall ulcer were noted to vary from an elliptical opening to an actual longitudinal split, extending from the calloused ulcer edge. Because of the rigid induration and fixation of the surrounding tissues, the closure of this type of perforation may not be easily accomplished and may be more readily followed by leakage and delayed healing. We noted this distinctive pathology in 6 of the 8 acute perforations which occurred at the lesser curvature.

If the pathology at the site of ulceration may serve to limit the effectiveness of a direct surgical closure of a perforation, we see no reason why it should not act similarly with the use of gastric aspiration, upon which the nonoperative treatment depends for inducing a spontaneous closing-off of a perforation. It is interesting that Stead in discussing the indications for that method speculates upon drawing a distinction between gastric and duodenal perforations. While the previous gastric history may be suggestive, the only certain way of determining the nature of the pathology at the site of perforation, is by direct surgical exposure.

COMPLICATIONS

Table I summarizes the type and incidence of complications which were encountered.

Our records indicate that there were only 19 cases of major postoperative pulmonary complications. These diagnoses were limited to cases definitely proved by x-ray examination or autopsy. The actual incidence undoubtedly was higher inasmuch as atelectases of varying extents are frequently overlooked.

There were 33 wound infections of which 20 were of mild character. There were 13 severe infections, which occurred principally in delayed cases with generalized peritonitis. Unfortunately, our data were not sufficiently complete for comment on the bacteriology of these infections. In no instance could a fatality be directly ascribed to a wound infection.

Leakage at the closure site resulting in abdominal fistulas occurred in 3 cases. The complications developed in 2 chronic penetrating gastric ulcers and in 1 posterior wall duodenal ulcer. All 3 patients succumbed to generalized peritonitis. The 2 patients, both with late perforations, who developed subphrenic abscesses, recovered after surgical drainage. There were 4 instances of pelvic abscess with recovery. A massive hemorrhage on the sixth postoperative day resulted in a fatal outcome in a case of gastric ulcer perforation of the lesser curvature.

There were 10 cases of wound dehiscence, but in none was there an actual free escape of bowel or omentum. All cases revealed a moderate protrusion of these viscera which were attached to the wound edges. In 6 instances, the poor general condition of the patient (malnutrition from alcoholism or chronic tuberculosis) could be definitely ascribed as a contributing factor to the wound disruptions. In 2 instances, severe coughing and vomiting in patients with pulmonary complications seemed to be the etiological factors. We found no evidence to base the wound disruption on the type of anesthesia or the method of wound closure. Two dehiscences occurred in patients whose abdominal walls were closed with interrupted figure of eight wire sutures through peritoneum, muscles, and fascia. One occurred following a closure utilizing interrupted heavy braided silk through all layers of the abdominal wall. The remaining 7 dehiscences occurred following layer closures utilizing chromic sutures. All 10 patients were treated by packing of the wound reinforced by a firm adhesive strapping. All survived except 1, in which postmortem examination revealed the cause of death to be a massive hemorrhage from the ulcer site.

It is our conviction, after a critical study of these complications, that the general condition

of the patient rather than the surgical procedure itself has been the principal factor responsible for their occurrence. Obviously, wound infections and dehiscences are two serious complications involving morbidity and potential mortality which are avoided by the nonoperative approach. The percentage incidence of wound infections has decreased impressively in the past 5 years. In no instance, were we able to ascribe a mortality specifically to a wound infection. This holds true for the wound dehiscences, which are always particularly life-threatening. It is well to emphasize that the nonoperative treatment is not immune to the other complications, for example, subphrenic abscess, pelvic abscess, bleeding.

Mortality. There were 23 postoperative deaths in this series of 219 acute perforations treated by simple suture (Table II). The statistical significance of these results may be better appreciated after a brief consideration of the factors, which contributed directly and indirectly to their occurrence.

The duration of perforation is a most important factor influencing mortality results. It will be noted in Tables II, III, IV, and V that such a large majority of our cases were treated within the first 6 hours of perforation that the comparative paucity of cases in the other periods may not contribute as much statistical significance to their respective results. Empiric experience has long shown that the mortality rate tends to increase sharply after the sixth hour of perforation because of the onset and progressive extension of a bacterial peritonitis. There is particular interest, therefore, in the factors, which contributed to the 12 deaths in the 177 cases treated within the first 6 hours (Table II). Peritonitis was the direct cause in 8 cases. The factors contributing to the peritonitis were leakage from the ulcer site in 3 instances, the debilitating effects of chronic alcoholism in 4 cases, and advanced cardiovascular disease in 1 patient. Pneumonia was the direct cause of death in 3 cases. Two of these patients had long-standing chronic pulmonary disease. One patient died on the sixth postoperative day from a massive hemorrhage arising from a sutured lesser curvature gastric ulcer.

The influence of the age of the patient upon our mortality results is indicated by the following summary of the data in Table II. In the 0 to 29 year age group there were 36 cases (16 per cent of total) with no deaths; in the 30 to 59 year group, 159 cases (73 per cent) with 13 deaths (8.2 per cent); in the 60 to 89 year group, 24 cases (11 per cent) with 10 (41.7 per cent) deaths.

It is upon the basis of these three age groups that we have recorded our data in Tables II to V. Again, it must be noted that our cases were concentrated so heavily in the 30 to 59 year age group that they overshadow the other groups in statistical significance. Likewise, it is worthy of note that, while there were no deaths in the 36 patients under 30 years of age, they all received treatment relatively promptly —30 within the first 6 hours of perforation and the remainder in the next 6 hours. In contrast, 5 of the 10 deaths occurring in the patients between 60 and 89 years of age were in acute perforations which had existed longer than 12 hours.

The important influence exerted by alcoholism upon our mortality results merits comment. Nine of the 13 deaths in the 30 to 59 year age group occurred in patients suffering from severe chronic alcoholism. Moreover, 7 of these 9 cases were treated within 6 hours of perforation.

The pathology at the site of perforation may be an important factor contributing to mortality. This factor is more likely to prevail when the perforation occurs within or adjacent to a chronic penetrating ulcer. As we previously noted, this pathology tends to exist in patients with long standing stories of recurrent activity, particularly when associated with complications. There were 39 such cases with 7 deaths.

It seemed particularly significant that 5 of these deaths occurred in acute perforations of lesser curvature gastric ulcers, of which there were only 8 in this entire series of 219 cases. All 5 fatal cases were treated within 6 hours of perforation with 4 patients being within the 30 to 59 year age group. One patient died from a massive hemorrhage on the sixth postoperative day, and 3 patients succumbed to peritonitis developing leaks at the sites of

TABLE II.—MORTALITY (1936–1950, INCLUSIVE)

Duration of perforation, hours	Total No. of cases	Deaths		Ages 0–29 years		Ages 30–59 years			Ages 60–89 years		
		No.	Per cent	No. of cases	No. of deaths	No. of cases	No. of deaths	Per cent	No. of cases	No. of deaths	Per cent
0– 6	177	12	6.8	30	0	134	8	6.0	13	4	30.7
6–12	21	3	14.3	6	0	10	2	20.0	5	1	20.0
12–24	19	6	31.6	0	0	14	2	14.3	5	4	80.0
24–48	2	2	100	0	0	1	1	100	1	1	100
Total	219	23	10.5	36	0	159	13	8.2	24	10	41.7

closure. In our opinion, particular significance must be given to the gastric ulcers of the lesser curvature when considering the factors contributing to the mortality in acute perforation. The comparatively high mortality results in the 1936 to 1940 period may be explained in part on that basis, inasmuch as 4 of the 5 mortalities which occurred in that period showed this pathology.

It is evident from a study of Tables II, III, IV, and V that the period of 1946 to 1950, which corresponds with the current method of employing simple suture, has yielded the best therapeutic results. Obviously, it is upon the basis of these results (Table V) that any comparative evaluation of the method's therapeutic usefulness should be made. When referring to the current method of carrying out the procedure of simple suture, we imply a program which follows the following pattern: After making the diagnosis of an acute perforation or strongly suspecting its possibility, operation is carried out as promptly as feasible unless the patient's condition obviously contraindicates surgical exploration or the use of an anesthetic. Careful consideration is given to the preoperative preparations, particularly with respect to overcoming shock and correcting fluid imbalance. As a rule, such physiological disturbances are readily adjusted by proper sedation and by the routine use of intravenous fluids (saline-glucose) immediately upon admission. Transfusion may be employed, if indicated. It has been exceptional to delay the operation more than 2 hours to improve the physical status of a patient. Intragastric suction by a Levin tube is instituted immediately and is continued postoperatively as long as it might be required. Careful consideration is given to the choice of anesthesia, which is given by a trained anesthetist who also bears the particular responsibility for the postoperative care of the potential anesthetic complications. While we make no particular brief for any particular type of incision, method of closing the ulcer, type of suture material, or method of wound closure, we require the procedure to be done expeditiously, nontraumatically, and with surgical judgment. Antibiotics are started routinely after operation. Fluid balance is maintained by parenteral means. Unless contraindicated, ambulation is begun on the first postoperative day. Atelectasis is looked for clinically and treated promptly by bronchoscopy or suction. Every effort is made to detect and treat thrombophlebitis as soon as possible. Until now, we preferred the use of anticoagulants.

TABLE III.—MORTALITY (1936–1940)

Duration of perforation, hours	Total No. of cases	Deaths		Ages 0–29 years		Ages 30–59 years			Ages 60–89 years		
		No.	Per cent	No. of cases	No. of deaths	No. of cases	No. of deaths	Per cent	No. of cases	No. of deaths	Per cent
0– 6	38	7	18.4	8	0	27	5	18.5	3	2	66.7
6–12	6	1	16.7	5	0	1	1	100	0	0	
12–24	7	2	28.5	0	0	4	0		3	2	66.7
24–48	1	1	100	0	0	0	0		1	1	100
Total	52	11	21.2	13	0	32	6	19.0	7	5	71.4

TABLE IV.—MORTALITY (1941–1945, INCLUSIVE)

Duration of perforation, hours	Total No. of cases	Deaths		Ages 0–29 years		Ages 30–59 years			Ages 60–89 years		
		No.	Per cent	No. of cases	No. of deaths	No. of cases	No. of deaths	Per cent	No. of cases	No. of deaths	Per cent
0– 6	61	3	4.9	6	0	51	2	3.9	4	1	25.0
6–12	7	1	14.2	1	0	4	1	25.0	2	0	
12–24	2	1	50.0	0	0	2	1	50.0	0	0	
24–48	0	0		0	0	0	0		0	0	
Total	70	5	7.1	7	0	57	4	7.0	6	1	16.7

Our present regimen reflects the various medical advances, which have been periodically adopted in the use of simple suture over the course of 15 years covered by this study. Inasmuch as the distinctive features of our clinical material had not changed significantly during that period of time, it seems reasonable to ascribe the improved clinical results for the years of 1946 to 1950 to those medical advances in general rather than to any particular influence. It is well to note also that the method of simple suture, as currently employed, actually incorporates all the measures utilized by the nonoperative treatment.

It is difficult to conceive of any method, other than a specific ulcer cure, yielding better therapeutic results in otherwise healthy individuals than we are now obtaining with the prompt use of simple suture (Table V). There had been but 1 death in 77 patients under 60 years of age treated within the first 12 hours of perforation. The 1 patient, 55 years of age and a severe chronic alcoholic, died 7 days after operation from a peritonitis resulting from a leak at the site of closure of a perforated chronic indurated penetrating duodenal ulcer. He died principally because of his poor physical condition, resulting from chronic alcoholism. In our opinion, the method of therapy had little to do with the final outcome. The deaths in our current experience with simple suture have occurred mainly in patients suffering from the effects of senility, debilitating diseases, and uncontrolled infection from delay in treatment. It must be recognized that a certain mortality rate is inevitable under such unfavorable circumstances, as long as no certain means of controlling ulcer activity exists.

Our data are insufficient to venture any statistical comment as to the contributing influences of the risk of surgery and anesthesia. We would seriously question Taylor's (5) contention that they account for more than one half of the mortalities prevailing with the use of simple suture today. We are more inclined to believe that most patients succumb because of a physical status so depleted of biological reserve that they are unable to overcome the immediate and subsequent life-threatening effects of an acute perforation, even though every possible support is rendered to them.

DISCUSSION

At the outset of this study we indicated our intention to follow a pattern of investigation which, in our opinion, may permit a reasonable consideration of the relative merits of the

TABLE V.—MORTALITY (1946–1950, INCLUSIVE)

Duration of perforation, hours	Total No. of cases	Deaths		Ages 0–29 years		Ages 30–59 years			Ages 60–89 years		
		No.	Per cent	No. of cases	No. of deaths	No. of cases	No. of deaths	Per cent	No. of cases	No. of deaths	Per cent
0– 6	78	2	2.6	16	0	56	1	0.2	6	1	16.7
6–12	8	1	12.5	0	0	5	0		3	1	33.3
12–24	10	3	30.0	0	0	8	1	12.5	2	2	
24–48	1	1	100	0	0	1	1	100	0	0	
Total	97	7	7.2	16	0	70	3	4.3	11	4	36.7

therapies employed for acute perforated peptic ulcers. We have accordingly reviewed our clinic's experience with the employment of simple suture during the period of 1935 to 1950, inclusive, with a recognition of the concurrent modifications in the method of its use. We are now prepared similarly to analyze the reported experiences with the nonoperative treatment of acute perforations which, according to its modern implications, first began to attract attention about 1946. In reviewing the literature from then until June, 1951, we are aware of 13 reports relating to 290 cases which were treated medically. In 11 of these studies representing 140 cases, the individual series ranged from 5 to 24 patients in number. Most of the reporters readily recognize the inadequacy of their data for statistical evaluation. In our opinion, the recent studies of Taylor (5) and Stead, relating to their experiences with the medical treatment of 101 and 50 acute perforations respectively, are the only reports thus far which justify analytical comment. We shall presently refer to these papers in considering the rationale and the method of employing the nonoperative treatment. It might be stated that, although Taylor cites his awareness of 555 medically treated cases of acute perforation, 300 were based on personal communications and are therefore not available for critical analysis. After carefully reviewing the reported experiences with the nonoperative treatment, we have found it impossible to correlate their results for any valid evaluation of the method's actual or comparative usefulness. For example, the technique of carrying out the therapy varied strikingly in different studies. Some clinicians utilized continuous intragastric suction, while others preferred periodic gastric aspiration. There was no uniformity in the use of antibiotics. In certain of the reports, the treatment was limited to selected cases, while in others, it was employed consecutively. Moreover, the accuracy of diagnosis not infrequently remained questionable. To summarize, it seems quite clear that sufficient factual evidence has not as yet been accumulated to permit a valid statistical evaluation of the therapeutic usefulness of the recently proposed medical treatment of acute perforation. Moreover, we strongly suspect that agreement on that score will long be delayed unless clinicians make a more determined effort to respect biometric technique in appraising their clinical results.

While we find insufficient evidence as yet from a statistical point of view to modify our clinic's preference for simple suture, we are aware that it might be contended that our consideration relating to the medical treatment of acute perforations has been too limited to permit a realistic appreciation of its nature and potential usefulness. To our knowledge, the recent reports of Taylor and of Stead are the only studies with sufficient factual background to offer such a perspective. In the report of Taylor, we get the point of view of one who has become convinced of the superiority of the nonoperative approach. In 1946 (4), he first presented a preliminary report of 28 medically treated acute perforations with 4 deaths, of which only 1 in his opinion could be reasonably ascribed to a failure of the method. In a further study (5), dealing with 73 cases, there were 7 deaths of which 5 were not considered to be related to the method of treatment. The other 2 deaths, which were regarded to be avoidable, were asserted to have resulted from a failure to appreciate that certain patients may be air-swallowers and thereby nullify the effectiveness of gastric aspiration upon which the rationale of the medical treatment is primarily based. Taylor asserts, "a perforation certainly will close itself, if the stomach is promptly emptied and kept empty, so that neither fluid nor gas pass through the aperture." Empiric experience has long shown that efficient intragastric suction can only be assured by vigilant supervision which entails a constant checking of the position and patency of the tube. It is Taylor's routine first to treat all acute perforations by promptly emptying the stomach. Continuous aspiration is then advocated as the procedure of choice, unless it becomes evident within the first 6 hours that it is not succeeding, when operation is promptly carried out. The supervision and vigilance that may be required in the first 6 hours from personnel responsible for the proper functioning of the intragastric tube, the periodic roentgeno-

graphic examinations to determine whether subdiaphragmatic gas may be increasing rather than receding, and the presence of an experienced surgeon to evaluate the clinical situation serve to make the medical treatment of acute perforation a far more exacting technical procedure than may be generally suspected. Taylor concludes from his experience that when the medical treatment is properly carried out, it can be relied upon to induce a closing off of most perforations, and when it fails, recourse still can be had to operation without significant added risk. He submits no formal biometric analysis of his data because he believes more can be learned from a descriptive account of the problems and failures of medical treatment in its present status than from inadequate statistics. This may be true, but too many contentions relating to the comparative advantage of the medical treatment await factual proof before they can be regarded to be more than matters of personal opinion.

In Stead's report dealing with 50 medically treated cases in a consecutive series of 76 acute perforations, we obtain a perspective of one who remains guarded and circumspect concerning the present status of medical treatment. He formally analyzes his data according to whether patients clinically were fit or unfit for operation and as to whether the perforations occurred in duodenal or gastric ulcers. In a group of 38 patients considered to be fit for operation, there were 2 failures, although only 1 patient died. This patient succumbed to a peritonitis from a perforation which was thought to have become sealed off promptly by aspiration. When the true status was appreciated, it was too late for operation. He concludes that if the failure rate of 1 death in 38 cases fit for operation should prevail in a large series of cases, it might condemn the medical method despite its advantages to the majority of patients. Of 12 patients regarded to be unfit for surgery, 8 survived. These results are sufficiently impressive to suggest that it is in such cases that the particular usefulness of the medical treatment is most likely to be found. Stead followed the routine of the treatment outlined by Taylor and expresses some doubt as to its general practicality, if experienced personnel are not available to carry it out. He infers it might be safer for an inexperienced surgeon to operate providing a competent anesthetist is available. Upon the basis of his experience of 5 deaths in 50 medically treated cases, with 4 of the mortalities being in 12 patients considered unfit for operation, Stead concludes that the conservative treatment of acute perforation is still on trial and the indications for its use are not yet established.

After a review of the experiences thus far reported with the medical treatment of acute perforation, there can be no doubt that the method presents an approach which warrants serious consideration in the therapy of that major complication of peptic ulceration. It is evident that gastric aspiration, when effectively carried out, may induce a spontaneous closure of an acute perforation, and in the vast majority of instances thereby obviate an operative procedure and its potential complications. However, it remains far from certain as yet that gastric aspiration can accomplish this primary objective of treatment *in any given case* with the assurance which empiric experience has shown may be obtained from the method of simple suture. This uncertainty stems not only from the complexity of an exacting technique, which depends for its success upon vigilant supervision and the availability of experienced clinicians, but also from the need for further clarification of a number of problems which arise when an acute abdominal emergency is treated expectantly. The answers to many of these problems await factual evidence, which may permit a comparative evaluation of mortality and morbidity results when simple suture and the medical treatment are employed under comparable conditions.

From the experiences of our clinic as well as those of others, it would seem difficult to equal —to say nothing of improve upon—the results we are now obtaining with simple suture in surgically fit patients treated soon after perforation. Therefore, considering the present insufficiently tested status of the conservative approach, we can find little justification in freely advocating its use as the procedure of choice. We find ourselves in complete ac-

cord with the following editorial view expressed by the *Lancet* (1): "It remains very doubtful whether conservative treatment, even conducted by an experienced unit, is equally safe for the patient, and we endorse the opinion that until the facts are clearer, it should be regarded as an experimental method to be left to those who are making a trial with the full knowledge of the risks under entirely favorable conditions."

CONCLUSIONS

In evaluating the methods of therapy for a complex clinical problem, such as an acute perforated peptic ulcer, the important consideration is not whether one therapy should be employed to the exclusion of another but rather wherein each may conceivably be used with the greatest advantage. Actually, such a consideration prompted this study. Despite our reservations concerning the conservative approach, we remain open-minded concerning its ultimate usefulness and are prepared to modify our clinic's current therapeutic policy whenever the factual evidence justifies it. At present, we are disposed to favor surgical exploration and the use of simple suture in all early acute perforations, whether the diagnosis is suspected or definitively proved, unless the condition of the patient contraindicates a laparotomy or the use of an anesthetic. Likewise, if a case is seen after a lapse of 12 to 24 hours without convincing clinical signs of localization, we still prefer this approach providing no operative contraindication exists. If the clinical evidence in such delayed cases indicates a definite spontaneous containment of the effects of perforation, we are prepared to entertain the use of the nonoperative method. Our decision, to a large degree, would be determined by the condition of the patient. Finally, we are prepared to modify our preference for the use of simple suture in acute perforations which occur within or adjacent to chronic calloused penetrating ulcer, particularly at the site of the re-entrant angle of the stomach. In such cases, in which closure may prove difficult or uncertain, a partial gastrectomy may be justifiable providing the condition of the patient is favorable and the experience of the surgeon is adequate.

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THE EFFECT OF THE INTRAVENOUS ADMINISTRATION OF MEPERIDINE UPON THE CIRCULATION OF MAN AND UPON THE CIRCULATORY RESPONSE TO TILT

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STUDIES of the circulation in man indicate that passive tilt to the head-up position results in a decreased right auricular pressure and a diminution of cardiac output (4), occasionally accompanied by fainting. A similarity between the hemodynamic effects of this postural change and of a hemorrhage experienced in the supine position has been noted (4). It appears valid to assume that passive tilt to the head-up position places the circulation of man under stress, and that maintenance of blood pressure and blood flow to the heart, brain, and other vital tissues is achieved through the competence of well known compensatory reflexes. A drug which interferes with cardiovascular homeostasis should manifest such an effect to a greater extent when the compensatory mechanisms of the circulatory system are subjected to the stress of a tilt. When the procedure of passive tilt is instituted following the administration of morphine, for example, the incidence of fainting increases significantly above that observed in normal subjects (7).

The frequent clinical use of meperidine suggests the importance of comparing the circulatory actions of this drug with those of morphine. Side effects similar to those noted after administration of morphine, i.e., dizziness, weakness and syncope, are occasionally observed in the ambulatory patient receiving meperidine (1) and indicate that meperidine may interfere with those compensatory mechanisms which maintain the circulation while an individual is in the upright posture. It therefore appeared desirable to investigate the circulatory effects of meperidine during passive tilt. This investigation also offered an opportunity for observing various reactions of man to the intravenous administration of the drug.

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METHODS

Twenty-six subjects, of whom 17 were male, were studied on a tilt table which supported the body by a footboard. The subjects, who were either medical students or ambulatory hospital patients, ranged in age from 21 to 71 years.

Continuous recordings of blood pressure and pulse rate were secured from a brachial artery by means of a Lilly capacitance manometer (8, 11). A constant reference point for pressure recording was maintained in order to eliminate a hydrostatic artefact related to the position of the arm and manometer head when the table was tilted. This was usually accomplished by maintaining the arm at right angles to the trunk during the tilt and using the aortic arch as the reference point. In those instances in which the arm remained at the side throughout, pressure readings were corrected by subtracting the pressure which would be exerted by a vertical water column extending from the aortic arch to the level of the manometer.

After a suitable control period to ascertain that blood pressure and pulse rate had stabilized, each subject was abruptly tilted to a 60 degree head-up position. This degree of tilt appears to approach the maximum that can be attained without leg fatigue and subsequent movement on the part of the subject. The control tilt was maintained for 15 minutes unless circulatory collapse supervened.

Upon resumption of the horizontal position, an intravenous infusion of 5 per cent glucose in water was begun very slowly (100 c.c. or less/hour), the purpose of the infusion being to allow subsequent administration of the drug without disturbing the subject by venipuncture.

When the blood pressure and pulse rate were again stable, the desired dose of meperidine (100 or 150 mgm.) diluted to 10 cubic centimeters with saline was injected into the infusion tubing close to the intravenous needle within a 1 to 8 minute period (Table I). Ten to 20 minutes after completion of the injection, the subject was again tilted to the 60 degree head-up position for 15 minutes or as long as was tolerated.

Most white subjects in whom a vein on the volar surface of the mid-forearm was used for drug injection showed a wheal and flare along the course of the vein. In order to investigate this phenomenon further, small amounts of meperidine (0.02 to 0.05 c.c. of a solution containing 50 mgm./c.c. of the drug without preservative) were injected intracutaneously on the volar surface of the forearm with a sharp 26 gauge needle. Seven subjects who had never received meperidine were so treated. For control, a similar volume of physiological saline was injected intradermally.

RESULTS

Since the respiratory cycle effects the blood pressure, several maximum and minimum blood pressure readings were averaged to obtain the values for systolic and diastolic blood pressure at the intervals indicated in the tables. The only exceptions are the values listed immediately (2 to 10 seconds) after the tilt, which represent the lowest pressure attained.

Circulatory effects of meperidine administered intravenously to subjects in the supine position. The blood pressure and pulse rate before and 3 to 5 minutes following the intravenous administration of meperidine are listed in Table I. This interval was selected because it represented the point at which the circulatory effects of the drug were usually maximal. In Tables II and III, the control data before the meperidine tilt indicate the effect 10 to 20 minutes after administration of the drug. These values show an extension of the previous trend in some cases and a return toward control levels in others. A longer period of observation before tilting was undesirable because it was necessary to have the maximum effect of the drug present throughout the tilt.

During the 10 to 20 minute period following administration of the drug, pulse rate increased in 21 subjects. In only 1 was there a substantial decrease in rate. The mean of the maximum changes in pulse rate, an increase of 11 beats a minute, is statistically significant ($p<0.001$).

The mean change of blood pressure was not statistically significant, because the alterations in blood pressure induced by the drug were so variable. Both increases and decreases of pressure were noted, the extreme in each instance being a change in systolic pressure of 40 millimeters of mercury.

Effects of meperidine upon the circulatory response to tilting to the head-up position. All of the 26 subjects were tilted before and after the administration of meperidine. Those showing no adverse reaction to either tilt are included in Table II. Table III includes those who had syncope, a marked decrease in blood pressure, or who vomited during either tilt. The immediate as well as the terminal effects of the tilt on pulse and blood pressure are listed in the tables.

Tilt before meperidine.—Three of the 26 subjects responded to the 60 degree head-up position with a marked decrease in blood pressure. Two of these fainted (8 per cent). One (subject No. 20) fainted after 11 minutes immediately following movement of the indwelling arterial catheter, although there was no subjective perception of discomfort from the vessel. This event occurred early in the series; care was taken in all subsequent studies to avoid movement of the arterial catheter. Rushmer has reported hypotension and cardiac slowing following arterial puncture performed in seated subjects. In our subject the cause of syncope appeared to be chiefly vasomotor rather than vagal, since there was no decrease in cardiac rate.

TABLE I.—EFFECT OF INTRAVENOUS MEPERIDINE—SUBJECT SUPINE

Subject	Sex	Age, years	Weight, pounds	Dose, mgm.	Period of injection, minutes	Control		3–5 min. after intravenous meperidine	
						Pulse	Blood pressure	Pulse	Blood pressure
1	M	22	165	100	6	86	116/74	100	134/80
2	M	22	148	100	4¾	84	128/79	90	136/81
3	M	23	156	100	7	64	136/86	88	158/98
4	M	21	150	100	2½	80	128/84	78	130/83
5	F	45	240	100	6½	76	226/128	75	212/121
6	F	43	158	100	3	71	141/77	71	154/78
7	M	39	139	100	6½	90	117/80	100	124/82
8	M	53	137	100	5	68	132/84	74	130/85
9	M	55	155	100	6	95	160/93	108	160/83
10	F	50	115	100	2⅝	76	136/80	83	147/92
11	F	42	124	100	6	83	135/81	114	128/78
12	M	59	167	150	3½	83	168/93	88	180/97
13	F	35	169	150	1¾	86	125/90	112	95/62
14	M	56	121	150	5	78	125/72	85	145/81
15	F	40	131	150	3	82	125/76	106	165/98
16	M	51	176	150	1	63	128/78	70	142/88
17	M	47	157	150	1¾	65	142/96	70	138/100
18	M	71	150	150	6	88	130/68	90	138/68
19	F	65	123	150	8	85	170/82	94	178/81
20	M	21	180	100	3	60	116/60	62	105/52
21	M	29	150	100	3	68	114/67	75	106/64
22	M	29	165	100	5⅔	58	109/70	94	125/82
23	F	53	197	100	6½	83	142/91	60	99/67
24	F	47	220	100	8	60	166/95	65	166/88
25	M	22	190	100	2½	74	105/73	82	114/78
26	M	22	185	100	6	74	140/85	72	127/74

Tilt after meperidine.—Tilts were repeated 10 to 20 minutes after the full dose of meperidine had been given (Tables II and III). Two subjects (Nos. 21, 22) vomited during the tilt, so that their circulatory reaction to the drug cannot be evaluated. In neither case was vomiting associated with hypotension, although one subject had fainted during the control tilt. Of the remaining 24 subjects, 4 (17 per cent) showed a marked decrease of blood pressure. Although all of the 4 had tolerated the control tilt, one (No. 25) had exhibited a marked but asymptomatic hypotension (59/46 mm. Hg).

The number of subjects showing circulatory depression during tilt following this drug is significantly less (chi square = 4.3; $p < 0.05$) than reported after administration of morphine to a group of similar size and age (7). Several factors must be considered in relation to this difference: the degree of tilt, the comparative dose, and the sex of the subjects. There is probably little difference in the effect of a 60 degree head-up tilt as employed in this study and the 75 degree tilt used in the morphine study (7). Movement of the lower extremities can be a potent factor in the maintenance of circulatory adequacy while in the head-up position. Preliminary tests indicated that subjects are more relaxed and less likely to move the legs when tilted to a 60 rather than 75 degree angle on a footboard tilt table. As a result the former position was selected.

TABLE II.—SUBJECTS TOLERATING BOTH TILTS

Subject	Control tilt						Dose mgm.	Meperidine tilt					
	before tilt		Circulatory effects 2–10 sec. after tilt		Terminal effect of 15 min. tilt			before tilt		Circulatory effects 2–10 sec. after tilt		Terminal effect of 15 min. tilt	
	Pulse	Blood pressure	Pulse	Blood pressure	Pulse	Blood pressure		Pulse	Blood pressure	Pulse	Blood pressure	Pulse	Blood pressure
1	79	128/88	105	100/68	117	111/79	100	84	134/90	117	106/74	134	100/70
2	79	121/75	90	110/66	87	123/78	100	100	137/83	110	106/68	120	133/82
3	56	127/78	66	117/69	85	109/68	100	85	153/89	100	129/85	90	136/88
4	78	130/80	98	113/84	106	126/92	100	78	135/85	115	114/77	112	128/84
5	82	235/135	84	215/122	99	194/124	100	75	211/116	78	185/107	85	165/107
6	68	142/79	80	112/66	92	129/77	100	70	142/72	95	101/64	128	124/79
7	85	115/83	100	105/71	90	114/78	100	102	128/89	102	98/64	96	127/93
8	73	126/80	80	92/63	95	94/67	100	75	132/83	82	90/62	95	90/65
9	100	175/98	100	156/87	102	152/82	100	110	141/84	118	114/73	102	138/82
10	79	150/92	83	117/73	96	102/60	100	80	147/88	90	103/67	84	114/78
11	89	142/98	100	118/85	116	124/90	100	118	120/77	130	92/60	105	102/73
12	88	175/91	100	138/72	104	169/95	150	95	179/102	103	168/96	96	138/88
13	92	133/94	95	115/85	112	119/93	150	96	145/98	118	112/80	120	138/90
14	90	130/74	96	102/57	106	115/76	150	88	128/72	92	114/68	85	106/68
15	85	126/81	105	110/70	100	115/75	150	97	158/98	100	135/85	92	121/77
16	75	132/81	67	106/71	78	115/74	150	67	132/82	79	118/72	90	116/78
17	66	140/93	70	120/83	98	136/100	150	70	142/95	72	130/90	72	127/92
18	90	135/70	95	96/67	90	114/58	150	87	139/75	89	128/65	84	105/54
19	90	175/80	93	106/56	98	130/64	150	95	187/86	96	163/70	87	119/61

There is disagreement among clinicians as to the relative potency of morphine and meperidine. Batterman assumed 100 milligrams of meperidine to be the equivalent of 10 milligrams of morphine, but stated that Barlow believed 125 milligrams of meperidine to approach the effectiveness of 17 milligrams of morphine. Until better methods of evaluating analgesia are available, such approximations must be accepted. In this study the largest doses of meperidine were 150 milligrams, while in the study of Drew and his associates some subjects received 20 milligrams of morphine intramuscularly. The intravenous administration of meperidine should tend to lessen any discrepancy of dose.

The influence of sex in relation to susceptibility to these drugs would be difficult to determine. The group receiving morphine was composed of a larger percentage of females than the group in the present study.

The most important difference in the two drugs appears to be in the effect upon older individuals. Drew and his associates pointed out that the highest incidence of fainting—60 per cent—occurred in the older age group composed of 15 subjects over 40 years of age. Only 14 per cent of a comparable age group exhibited circulatory collapse when tilted after meperidine. This difference in the incidence of fainting is highly significant (chi square $=7$; $p<0.01$).

The two groups are directly comparable; no statistically significant difference in age exists.

Examination of the continuous arterial pressure recording revealed no certain way of predicting complete circulatory deterioration during a tilt. It is interesting to note, however, that during the control tilt, systolic pressure fell more than 25 per cent immediately after tilting in 7 subjects. All 4 of

TABLE III.—SUBJECTS WITH VOMITING, SYNCOPE OR MARKED HYPOTENSION DURING TILT

Subject	Control tilt							Dose mgm.	Meperidine tilt						
	Before tilt		Circulatory effect 2–10 sec. after tilt		Terminal effect of tilt		Duration of tilt in min.		Before tilt		Circulatory effect 2–10 sec. after tilt		Terminal effect of tilt		Duration of tilt in min.
	Pulse	Blood pressure	Pulse	Blood pressure	Pulse	Blood pressure			Pulse	Blood pressure	Pulse	Blood pressure	Pulse	Blood pressure	
20	56	121/71	90	110/70	94	49/31	11 (a)	100	62	130/78	85	105/60	115	94/56	15
21	60	116/72	65	112/66	90	122/81	15	100	84	115/64	90	95/52	102	96/54	10 (b)
22	65	127/85	62	115/73	56	54/30	12 (c)	100	75	120/72	83	109/68	82	122/78	7½ (b)
23	80	138/87	87	100/59	105	129/86	15	100	72	118/78	80	82/46	56	43/31	15 (d)
24	62	160/84	61	111/68	75	134/89	15	100	67	172/96	70	125/81	76	63/40	4 (c)
25	66	112/68	110	73/57	132	59/46	15	100	92	116/70	130	72/52	134	53/44	6½ (e)
26	70	142/87	102	98/68	120	107/78	15	100	74	125/70	110	83/58	130	66/53	10 (c)

(a) Syncope from arterial stimulation
(b) Vomiting
(c) Syncope
(d) Unresponsive at 11 minutes (cerebral anemia)
(e) Visual "blackout"

those individuals exhibiting circulatory collapse during the meperidine tilt were in this group.

The circulatory collapse which occurred during a tilt following meperidine developed gradually over a prolonged period suggesting gradual pooling of blood in dependent portions of the body together with incomplete compensatory constriction in those regions in which such a reaction ordinarily takes place. This might be due to a histamine-like effect of the drug. This may be contrasted with the development of spontaneous syncope and syncope due to arterial stimulation which occurred in the subjects before the administration of the drug. In both instances the onset of collapse was evident only 30 to 90 seconds before syncope. This latter response suggests a sudden "break" in compensation, probably rapid dilatation of previously constricted vessels, a phenomenon that has been observed during hemorrhage (2), and during tilt (4).

Other effects of meperidine. Following the injection of meperidine, all subjects showed varying degrees of cerebral depression, which had perceptibly waned in intensity within an hour. One (No. 13) was completely anesthetized for 15 minutes, with reflexes sufficiently obtunded to permit the placement of an oral airway. Twenty minutes after injection of the drug she could be aroused sufficiently for a tilt to be performed. Many subjects fell asleep during the tilt after meperidine.

Dizziness was commonly reported during injection of the drug; it bore no relation to alterations in blood pressure. Sweating and facial pallor were frequent side effects which always became more pronounced during the tilt. Many subjects perspired so profusely that the sheet on which they lay was soaked.

Nausea was associated with injection of the drug in 3 subjects; 1 retched but did not vomit. Upon tilting, no such difficulties were encountered by these individuals, but 4 others became nauseated and 2 vomited. Vomiting, which was only encountered in the younger subjects, necessitated return to the supine position.

Intradermal injection of meperidine. Within 10 minutes, all 7 subjects receiving intradermal injections of meperidine developed a wheal (10 to 22 mm. in diameter) and a larger surrounding flare. Many of the wheals showed pseudopods. Sites of saline injections were negative. This response, which lasted for over an hour, is suggestive of histamine liberation. Nasmyth and Stewart have noted this effect, and report that it can be minimized by antihistaminic drugs.

It is evident that a sensitivity test for meperidine by intracutaneous injection is im-

practical, since all of the individuals tested developed a wheal and flare. In this respect the drug is similar to morphine.

DISCUSSION

Meperidine, packaged as "demerol®," is labelled "for intramuscular use only." Batterman has suggested that the drug not be given intravenously because of the danger of hypotension. Nevertheless, the use of meperidine by vein is increasing (5, 6). Our results indicate that the relatively slow intravenous injection of meperidine to supine subjects is associated with no severe circulatory changes. There is little reason to believe that it is any more dangerous to give meperidine intravenously than morphine (7, 10) assuming that the same precautions are used with both drugs, i.e., slow administration of a dose compatible with the physical status of the patient. Intravenous administration may not often be the route of choice, but on occasion it is of particular advantage to give drugs in this way to injured persons to assure adequate absorption and immediate pain relief (3). The maximal cerebral depressant effects of the drug when given in this manner appear to be exerted within 3 to 5 minutes. Since most of this depression seems to wear off within an hour after a single dose, frequent small doses may be more effective.

On the basis of these studies it is apparent that meperidine as well as morphine (7) may decrease the ability of man to tolerate the circulatory stress of tilt. Presumably there would also be a less adequate response to other conditions imposing a strain on the compensatory mechanisms of the circulatory system, such as shock or hemorrhage, for it is believed that the hemodynamic effects of a tilt to the head-up position are not unlike those imposed by a sudden reduction in circulating blood volume (4). The clinical implications of these findings are evident and have been presented elsewhere (7). It should be emphasized that hypotension may ensue following the administration of meperidine to the supine patient if a chronic or acute blood volume deficit exists. The route of administration would probably have little influence on this response.

The causes for this action of meperidine are probably several and include the following possibilities: (1) vasodilation either by a direct local action of the drug, through liberation of histamine, or by central vasomotor depression, (2) diminished "respiratory pump" mechanism.

Tilts following meperidine show a much lower incidence of circulatory collapse than similar tilts after the administration of morphine. One may assume that this could be partly due to small differences in relative dosage and degree of tilt. The major difference appears to be in the effect of the drugs themselves upon the circulatory system. Since the incidence of collapse was essentially the same with both drugs in the 20 to 30 year old group but was different in older subjects, it would appear that meperidine may be of particular value in older individuals.

SUMMARY

1. The effect of meperidine upon the circulation has been studied in 26 subjects.

2. Tilting to a 60 degree head-up position after administration of 100 to 150 milligrams of meperidine increases the incidence of circulatory collapse from this postural change. Each subject acted as his own control.

3. The incidence of circulatory collapse from tilting is significantly less after meperidine than after morphine in subjects of the older age group.

4. Meperidine appears to liberate histamine which could cause peripheral vasodilatation.

5. The intravenous administration of the drug causes an increase in pulse rate and variable changes in blood pressure in subjects in the supine position. This route appears reasonably safe in normal individuals.

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ROENTGEN THERAPY OF CARCINOMA OF THE LARYNX

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THE optimum treatment for cancer of the larynx depends on many factors, such as the size and location of the tumor, the mobility of the cords, the age, general health, and mental attitude of the patient, and whether or not the nodes of the neck are clinically involved. In early cord cancer, roentgen therapy apparently gives as good results as surgery in terms of survival or cure, and superior results in terms of function. In advanced cord cancer, with cartilage invasion or marked secondary infection, and in extrinsic laryngeal cancer, it is believed by many that radical surgery gives chances of survival superior to those obtainable with x-ray.

The following paper is a report based on our experience with 132 cases of cancer of the larynx treated by roentgen therapy during the last 18 years. Sixty-nine of these cases were treated prior to 1946 and are therefore suitable for 5 year analysis. About two-thirds of them were seen on a county hospital service and therefore constitute relatively unfavorable or advanced material.

DIAGNOSIS

All of the cases seen by the authors and their associates were referred by laryngologists or other surgeons and were histologically verified. The 69 cases suitable for 5 year study were all of squamous cell carcinomas. In 2 additional cases, the existence of carcinoma at the time of roentgen therapy was questioned on subsequent review; these have been *excluded* from this report. One was a patient with a very small biopsy, originally interpreted by the pathologist as carcinoma but subsequently reported as probable leucoplakia. The other was a patient with recurrent carcinoma following laryngofissure; after biopsy verification of the recurrence, the patient was started on roentgen therapy, but discharged himself from treatment prior to its completion. He received a tumor dose of only 2,500 roentgens in 10 days, and was alive and well 5 years later. It is possible that the second biopsy removed all of the recurrence. He is excluded.

Radical roentgen therapy is a major undertaking, and we believe that every therapist should seek thorough clinical and microscopic validation of a diagnosis of cancer before undertaking curative treatment.

An attempt was made to classify all cases according to the location and estimated extent of disease, by using the classification shown in Table A. Roentgenographic examination (including tomograms) of the larynx and pharynx was of some value in this staging, and provided a permanent record of the status of adjoining structures. Needless to say, the precise site of origin of some advanced lesions could not be established.

The classification employed is not regarded as an ideal one. However, it seemed to be the most practical clinical one at the time of our first report on this work in 1934, and for purposes of consistency we have adhered to it since that time. Further, it is comparable to many in use by other radiotherapists.

TABLE A.—CANCER OF LARYNX: CLINICAL CLASSIFICATION AND STAGING

Intrinsic. Tumor arising from true cord or laryngeal ventricle.
- Stage I—Single cord, without fixation.
- Stage II—Both cords, or one cord with partial fixation.
- Stage III—One or both cords, with cartilage invasion or metastases.

Extrinsic. Tumor arising from upper surface of false cord, epiglottis, aryepiglottic fold, arytenoid, laryngeal surface of pyriform sinus or postcricoid area.
- Stage I—Less than 1 cm. in diameter.
- Stage II—From 1 to 3 cm., but without cartilage invasion.
- Stage III—Over 3 cm., or with cartilage invasion, or metastases.

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Clinical classification is useful for guidance in selection of therapy and also for purposes of prognosis. Most small tumors, especially true cord lesions, offer a good prognosis for cure, surgical or radiotherapeutic. Many more extensive tumors also can be controlled by irradiation, but the cure rate falls rapidly, and radical surgery is probably a superior method of treatment in certain of these cases. The significant factor omitted in our classification is a clue to the "biological type" of the cancer in a given case. This, of course, is undeterminable in the present stage of our knowledge of tumors. It is not demonstrably correlated with microscopic morphology but seems to bear some relation to the clinical rate of the growth of the lesion.

In many cases, the biopsy specimen was graded by the pathologist into one of three general groups: well differentiated, poorly differentiated, and unspecified type of epithelioma. Jackson and Blady, Mustakallio, Lenz, and others found some correlation of prognosis and radiocurability with grading, but Harris, Lederman, Cutler, and others regarded grading as unreliable for such purposes. Our small experience has led us to concur in this latter opinion.

The apparent anatomic location of the primary tumor in the 69 cases treated was as follows: In the intrinsic group (a total of 31 cases), involvement of the anterior two-thirds of the vocal cord in 3 cases; of the posterior third of the vocal cord in 1 case; of the entire vocal cord in 13 cases; of both cords in 11 cases; of the cord with subglottic extension in 1 case; unclassified in 2 cases. In the extrinsic group (a total of 38 cases), involvement of the epiglottic in 12 cases; of the aryepiglottic fold in 1 case; of the arytenoid in 6 cases; of the false cord in 3 cases; of the pyriform sinus in 7 cases; of the postcricoid area in 1 case; unclassified (extensive) in 8 cases.

The clinical stage of the different lesions varied widely, a majority being in stage III. The following summarizes the stages in the 62 cases in which treatment was completed. In the intrinsic group (total 29 cases), 3 cases in stage I, 8 in stage II, 18 in stage III. In the extrinsic group (total, 33 cases), 1 case in stage I, 5 in stage II, and 27 in stage III.

TREATMENT

The irradiation technique employed in our cases is based on the earlier principles of Coutard, whose clinic at the Institut du Radium one of us (L.H.G.) was privileged to visit in 1932, prior to the start of the investigation. Each patient is examined by mirror before, during, and after completion of therapy. At the time of the first treatment, the estimated center of the tumor is marked on the patient's skin (on either side of the neck) under fluoroscopic guidance, with the patient lying on his side in the precise position he will occupy on the treatment table. When necessary, spot films are made with a small lead marker over the central point. Precision in aiming the subsequent beam of roentgen rays is essential, and each case is set up and observed by the radiotherapist at every treatment visit. Whenever possible, the entire course is given under the personal direction and supervision of the therapist who initiated the course.

The usual technical factors of 200 to 250 kilovolts, 15 to 25 milliamperes, half value layer of 1 to 2 millimeters of copper, and distance of 50 to 70 centimeters were used throughout this series. The major variables were field size and duration of treatment. Most cases were started with two directly opposing 10 or 8 centimeter circular beams, and the beam size was gradually reduced during therapy when such was considered advisable —but rarely below 5 centimeters in diameter. In recent years, a beam of small size tended to remain unchanged throughout the course. A few of the very advanced or extensive lesions were treated through large, 10 by 14 centimeter fields initially. In some of the first treated cases, an anterior field also was irradiated; this was subsequently dispensed with. No bolus bags were used.

Except in the presence of a very narrow airway, the initial dose was usually 100 roentgens in air to one lateral field. This was increased to 150 roentgens next day, and 200 roentgens on the third, in the absence of undesirable reaction (treating alternate sides daily). Treatment was continued at the rate of 200 roentgens a day to one field, for another few days and, in some cases, increased to 250 or 300 roentgens, depending on the individual prob-

TABLE I.—FIVE YEAR RESULTS IN 69 PRIMARY CASES OF CANCER OF LARYNX (FOR PERIOD 1933–1946)

	No. patients
Treated	69
Treatment incomplete	7
Treatment complete	62
Died of cancer (failures)	23
Died of various causes (larynx apparently healed)	8
Died of other causes, without evidence of cancer (autopsy check in 6)	16
Lost to follow-up but well when last seen	2
Living and well 5 or more years	13

lem. The larger the field, the smaller the daily dose tended to be.

Treatments were given daily, 6 days per week, until the planned dose had been administered or the planned mucosal reaction produced in the larynx. In many cases the planned dose was 5,000 roentgens to tumor in 4 weeks. This required about 3,000 roentgens in air, to each of the two lateral fields, in 28 treatment days. In a few cases treatment had to be suspended prior to completion because of severe local or general reaction or because of complications unrelated to therapy (debility, bronchopneumonia).

When epithelitis did not appear at the expected time, treatment was continued for a few additional doses, but rarely to exceed a total of 3,500 roentgens in air to each side of the neck, except under unusual circumstances.

The epithelitis present at or near the end of treatment usually took 2 to 4 weeks to subside and, in favorable cases, the tumor usually disappeared by the time the mucosal reaction was fully healed. However, in a fair number of cases, complete disappearance of the mass or swelling in the area of the primary tumor required as long as 3 months following cessation of treatment. Some of these cases were a source of apprehension, since early surgical treatment might have been advisable in the presence of established residual tumor. In general, we do not believe that 3 months is too long a posttherapeutic observation period in cases showing recession.

The side effects and complications of treatment have been dealt with in other publications and do not need reiteration here.

TABLE II.—FIVE YEAR RESULTS IN 62 CASES OF CANCER OF LARYNX

Site →	Intrinsic			Extrinsic		
Stage →	I	II	III	I	II	III
D.D.		1	9		2	11
D.?.D.			2			6
D.O.C.	1	5	3			7
Lost					1	1
L.W.	2	2	4	1	2	2
Total	3	8	18	1	5	27

D.D., dead of disease (cancer of the larynx)
D.?.D., dead, status of larynx uncertain
D.O.C., dead of other causes, larynx clinically well (verified by autopsy in 6 cases)
Lost, lost to follow-up
L.W., living and well

RESULTS

The immediate and late results of treatment of tumors arising in elderly persons are apt to be somewhat discordant. While a good proportion may show initial arrest by roentgen therapy (or surgery), many may die of intercurrent disease—with the tumor apparently controlled—prior to the time of the desired 5 or 10 year follow-up period, as in our group of cases.

Of the 69 cases of primary cancer of the larynx submitted to radical roentgen therapy, 7 patients failed to complete treatment for a variety of reasons—terminal cases with bronchopneumonia, advanced cases with tracheoesophageal fistula, and cases in persons too old or feeble to tolerate daily visits to the therapy table. This leaves 62 patients who completed treatment. Sixty of these were traced; 23 died of cancer; 8 died of other causes, but the status of their laryngeal lesions was not certain; 16 died with their larynges clinically or microscopically healed; and 13 are living and well 5 or more years (Table I).

Of the 62 patients who completed treatment, the lesions were almost equally divided between intrinsic and extrinsic. The results by stages may be seen in Table II.

If those dying of other causes (intercurrent disease) and those lost track of but clinically well when last seen are excluded—a total of 18 patients—there remain 44 determinate cases with a relative cure rate of 30 per cent (Table III).

TABLE III.—CANCER OF LARYNX: FIVE YEAR ARRESTS (X-RAY)

	No. patients
Total cases	62
Less indeterminate group, i.e., those dying of intercurrent disease within the 5 yr. period and free of cancer (autopsy 6)	16
those lost track of, but well when last seen.	2
Determinate group	44
Living and well	13 (30%)

TABLE IV.—CANCER LARYNX: FIVE YEAR ARRESTS BY STAGE

	Per cent
Intrinsic	
Stage I—2 of 2 determinate cases	100
II—2 of 3 determinate cases	66
III—4 of 15 determinate cases	27
Extrinsic	
Stage I—1 of 1 determinate case	100
II—2 of 4 determinate cases	50
III—2 of 19 determinate cases	10

The relationship of stage to survival is evident from a review of the results in early and advanced cases. For the determinate group, this is shown in Table IV. It is realized that the number of cases in any one group is too small to warrant figures in "percentages"; however, for purposes of comparing the results obtained in the different stages, percentages are convenient and, we believe, permissible.

The preceding paragraphs and tables deal with *5 year arrests* or clinical cures. The immediate or initial arrest rate also invites consideration in a tumor involving persons as old as most patients with laryngeal cancer. It is realized that some of these initial arrests *are* temporary, and that the patient might have developed recurrences had he lived out the full 5 year period or longer, but the figures are comparable with some appearing in the surgical literature and merit review. As in the case of late results, the lesions staged I and II give much better response than the advanced ones (Table V).

The advanced nature of many cases in patients referred to a radiotherapist, especially in the earlier years of radical laryngeal roentgen therapy, is illustrated by the proportion requiring tracheotomy *prior* to therapy. Of the total group of 69 primary cases referred for treatment, 18 patients already had required tracheotomy (26 per cent) and 8 had cervical node metastases. It is probable that some of these would no longer be accepted for radical roentgen therapy, and would instead be recommended for radical surgery. Four of the entire group required or were given tracheotomy during treatment, and 2 following completion of therapy. Two of the group developed chondronecrosis, 1 approximately 3 months following therapy, and one 8 years after such. Two developed recurrences, 1 at the end of 3½ years and 1 at the end of 7½ years following therapy. These complications and recurrences are summarized in Table VI.

DISCUSSION

Correlation of dosage with clinical cure. In the 13 cases which were arrested for 5 or more years, the estimated mid-tumor dose ranged from 4,500 roentgens in 30 days to 6,300 roentgens in 52 days. In most cases the dose was approximately 5,300 roentgens in 35 days (requiring, on the average, 3,200 roentgens in air to each of two opposing lateral neck fields). These doses are in the low range of those commonly accepted as curative for squamous cell cancer, but in our experience they represent about the maximum tolerated by the normal tissues adjacent to the tumor, using our type of treatment factors. Increasing the dose might increase the number of cures but would, we believe, unquestionably increase the incidence of chondronecrosis.

We recalculated the mid-tumor dose according to Strandquist's fractionation curve for a hypothetical standard 35 days in each case of the 13 arrested lesions and found that the range was from 4,400 to 6,500 roentgens (with an average of 5,334 roentgens) in 35 days (Table VII).

TABLE V.—INITIAL RESULTS OF ROENTGEN THERAPY IN CANCER OF LARYNX

	No. cases
Arrest rate in "early" or "moderately extensive" lesions	
Intrinsic	
Stages I and II treated	11
Arrested	10 (90%)
Died intercurrent disease.	6
Living and well over 5 years	4
Arrest rate in "late" or extensive" lesions	
Intrinsic	
Stage III treated	18
Arrested	7 (39%)
Extrinsic	
Stage III treated	27
Arrested	10 (37%)

TABLE VI.—COMPLICATIONS AND RECURRENCES IN 69 CASES OF CANCER OF LARYNX

Patients requiring tracheotomy	No. patients
Before radiotherapy	18
During radiotherapy	4
After radiotherapy	2
Necrosis following therapy	2 (3 mo., 8 yr.)
Recurrence after 3 years	2 (3¼ yr., 7½ yr.)

The *rate* of administration is probably as important as the total dosage in the development of troublesome early edema or late chondronecrosis. Both complications can virtually be avoided by graduation of dosage in the initial stages, and by avoidance of excessive dosage in the latter.

Late chondronecrosis attributable to roentgen therapy developed in 1 case in which reirradiation was used 8 months after the initial course of treatment. This is the only case in the entire series in which a second course of treatment was given, and in this case it was given owing to a misunderstanding. The patient was a man of 50 with a stage III extrinsic tumor (the left arytenoid, pyriform sinus, and true cord were involved). After a moderate course in June 1940 totalling 2,000 roentgens in air to each of two large fields his tumor disappeared and treatment was discontinued.

TABLE VII.—TUMOR DOSES IN PATIENTS WELL 5 OR MORE YEARS

Case No.	Mid-tumor dose r/days	Corresponding tumor dose/35 days*	Average diameter of x-ray beam (cm.)
2	5550/40	5200	7
17	5500/25	6250	10
23	5200/43	5000	8
26	5400/38	5250	7.5
28	4400/35	4400	7.5
40	5500/45	5100†	9
42	6300/52	5500	8.5
46	4500/30	4900	6
47	4900/30	5150	7.5
51	6100/31	6500	9
53	5800/35	5800	9
66	5400/46	4900	5
68	5500/37	5400	6.5

Range 4,400–6,500 (5–10)
Average 5,334 (7.6)
*Based on Strandquist's fractionation curve.
†This case also had additional treatment: see text.

TABLE VIII.—PRESENT STATUS OF 5 YEAR "CURES"

Serial No.	Well, years	Present status
2	8	Died, intercurrent disease
17	5	Untraced after 5th year
23	13	Died of coronary occlusion
26	14	Living and well
28	5	Died of coronary occlusion
40	8	Died of bronchopneumonia (necrosis)
42	9	Untraced after 9th year
46	11	Living and well
47	11	Living and well
51	10	Living and well
53	9	Living and well
66	5	Living and well
68	5	Living and well

In February 1941 he had evidence of recurrence and was re-treated to a similar dosage. His tumor again disappeared and he survived well until June 1948 when he developed chondronecrosis, with secondary bronchopneumonia, and died.

Early chondronecrosis developed in 1 case, after moderately intense treatment (3,600 roentgens in air to each of two fairly large fields in 40 days). The patient, a man of 49 years, had a stage III extrinsic lesion (squamous cell carcinoma of the epiglottis with cartilage involvement). Three months after completing treatment he developed edema and chondritis and succumbed.

We believe that moderation in therapy, as currently practiced, has eliminated the hazard of chondronecrosis of purely radiation origin. It may still be anticipated in the occasional patient with masked chondral infection present prior to therapy. Prompt laryngectomy will probably salvage such patients. Vigorous treatment with modern antibiotics should also help.

Permanence of results. When cure is achieved by roentgen therapy, we believe that the results are just as permanent as those obtained by other methods. In Table VIII are the records of the 13 cases of 5 year "cures" reported herewith.

Treatment of postirradiation failures. It is believed by some surgeons and radiotherapists

that early surgical removal is indicated in the presence of persistent or recurrent tumor following irradiation. In recent years it has been well established that surgical dissection and subsequent wound healing are not interfered with by properly administered, *single* courses of radical roentgen therapy. Our own experience with postradiotherapeutic surgery is too small to warrant definite opinion.

Metastatic nodes. When there is clinical evidence of involvement of one or two nodes immediately adjacent to the larynx, and these can be included in the beam used for treating the primary lesion, roentgen therapy has been sometimes successful. However, when the nodes are numerous, or are situated in the deeper cervical tissues at some distance (e.g., over 5 cm.) from the edge of the primary tumor, we have not obtained any cures. Frankly, we believe that palliation is all that can be offered most such cases; surgery even of the most radical type is rarely curative.

Arrest was obtained in 3 of the 8 cases with nodes in this series, but unfortunately all 3 patients died of unrelated causes prior to the lapse of 5 years' time.

When nodes develop following control of the primary, three courses are open. (a) When the node is solitary and at some *distance* it may be excised or verified by aspiration biopsy and local intense postoperative irradiation given. (b) When the nodes are in the formerly treated area or are multiple, but apparently operable, neck dissection is warranted. (c) When the nodes are multiple and fixed, only palliative irradiation is indicated.

Results in the literature. The results of surgical treatment of suitably selected early cord cases are reported in the 70 to 85 per cent range, and of selected cases of total laryngectomy in the 50 to 60 per cent range. It is not possible to compare with any accuracy these surgical figures and most roentgenological figures. The former deal almost essentially with *operable* cases; the latter with *operable, inoperable,* and *recurrent* cases. The following are published relative 5 year cures by roentgen therapy, all types of case considered: Coutard (142) in 1938 reported 27 per cent cures; Schinz (39) in 1939, 25 per cent; Nielsen and Strandberg in 1942, 22 per cent; Mustakallio in 1944, 30 per cent; Lenz in 1947, 27 per cent; Cutler in 1948, 35 per cent; Blady and associates (69) in 1948, 51 per cent; Baclesse (260 one series and 59 another) in 1948, 20 and 34 per cent, respectively; Cutler (156) in 1950, 37 per cent; Harris and associates in 1950, 56 per cent.

With the exception of the last figure which pertains (in the authors' words) to material "more favorable than the average," and Blady's small series, it is seen that the range is from 22 to 37 per cent. Our own figure, as previously noted, is 30 per cent.

The results of Hayes Martin, about 10 per cent, and of the Holt Radium Institute, about 14 per cent, pertain so largely to advanced disease that they require separate consideration. Harris and his associates have already discussed Martin's material. The following is a summary of the most recently published Manchester material: cases without nodes, intrinsic 32 per cent 5 year arrests, extrinsic 13 per cent arrests; all cases (i.e., both without and with nodes) intrinsic 26 per cent, extrinsic 6 per cent. Combined results in 236 cases are 14 per cent crude 5 year survival.

When cases from two representative clinics in this country are divided into intrinsic and extrinsic groups, the following relative cure rates are published: Blady and associates, 59 and 25 per cent; Harris and associates, 75 and 40 per cent.

Again, these figures require interpretation in the light of the relative proportion of early and late cases in each group. In addition to their being in the hands of very skilled roentgenotherapists, it is apparent that both Harris' and Blady's series contain a higher proportion of early lesions than most reported groups. Our own results are of course inferior to either of these series (being respectively 40 and 20 per cent); we believe it is fair to attribute this partly to advanced stage of many of our cases.

Palliative effects of roentgen therapy. In primary inoperable cases, and in cases recurrent after operation, significant palliation may often be achieved by judicious treatment. Space does not permit consideration of this important phase of the problem at this time.

Use of other types of roentgen therapy. Many varieties of ionizing beam are at the disposal

of the radiotherapist. Since about 1920, "supervoltage" beams in the form of the radium cannon (Berven), the radium collar (Murdoch), and the radium palisade (Finzi-Harmer) have been used. Since 1930, supervoltage x-ray beams from units operated at 1,000 and 2,000 kilovolts have been tried. Since 1932, rotation therapy, contact therapy and other variations in the medium and low voltage roentgen beam range have been employed. We have seen the results of treatment in some of the cases treated with most of the above technical variants. However, no data have been published to show superiority in results to those obtainable with conventional roentgen therapy as initiated by Coutard and followed by many radiologists throughout the world.

When opposing lateral fields are used, there is no particular physical advantage to supervoltage, or the radium (or cobalt) cannon. With single fields, the betatron and synchrotron may have some physical advantage, but their place in clinical radiotherapy of laryngeal lesions remains uncertain.

SUMMARY

The authors' experience in the treatment of 132 cases of cancer of the larynx is briefly reviewed.

The results in 69 primary cases treated 5 or more years ago are summarized.

Of 62 cases in which treatment was completed, 31 were clinically arrested following treatment (50 per cent); 16 of these patients died of intercurrent disease prior to the lapse of 5 years and 2 were lost to follow up. Of the "determinate" group of 44 cases, 13 patients were alive and well after 5 years (30 per cent).

Of 11 determinate cases, both intrinsic and extrinsic, classified as stage I or II (that is, in the conventionally "operable" group) 7 patients were alive and well 5 or more years (64 per cent). The cure rate for the intrinsic lesions alone (stages I and II) was 80 per cent.

Roentgen therapy of selected cases of early and moderately advanced carcinoma of the larynx is regarded as the optimum method of treatment for functionally satisfactory results.

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PENETRATING WOUNDS OF THE HEART

A Report of 81 Cases

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A REVIEW of the literature indicates that in recent years there has been a substantial decline in fatalities from wounds of the heart. Excellent results have been attained in well organized surgical units, alert to the diagnosis of cardiac wounds, and with an experience in their management.

It is a matter of clinical record that patients, lasting long enough to reach the operating table and to undergo surgery, have invariably revealed pericardial tamponade in association with the heart wound. The acceptance of tamponade as a practically constant finding has been responsible, more than anything else, for the renaissance of interest in aspiration as a method of management of cardiac wounds.

As will be noted shortly in our case analyses, only 2 patients with myocardial wounds reached the operating room without having developed tamponade, and these patients died on the table from exsanguination before effective surgery could be done. Likewise, in a group of 12 patients who did not survive long enough to reach the operating room and in whom death was attributable solely to the heart injury, autopsy protocols indicate that tamponade did not develop and that extrapericardial exsanguination was the cause of death.

As a result of our experience, we have come to the conclusion that the basis for survival in penetrating wounds of the heart is: (1) the development of acute pericardial tamponade; (2) the relief of that tamponade before its nocuous effects cause death; (3) the prevention of recurrence of tamponade.

Tamponade is both lethal and life saving. There is little doubt that, up to a point, it does contribute to the reduction or cessation of hemorrhage from the cardiac wound, but beyond that point a continuance of its action may prove fatal.

At Harlem Hospital over a period of 25 years, we have been committed to surgery as the method of choice in the management of cardiac wounds. We are convinced that the only certain way to eliminate tamponade and prevent its recurrence is through pericardiotomy and primary cardiorrhaphy. This does not imply that we are opposed to aspiration as definitive therapy. It has been too convincingly demonstrated by Blalock, Ravitch, Elkin, Anderson, and others (1, 5, 6, 10, 13) that in selected cases, under strict surgical surveillance, aspiration can be a valuable and effective method of management. However, with an eye for the practical and the expedient in the administration of our large and active emergency service, operative treatment has been preferred.

GENERAL STATISTICS

This is a report on 81 patients with wounds of the heart admitted to Harlem Hospital from January 1938 to May 1951. Twenty died before surgery could be done, and 61 were operated upon, of which 35 were saved for a recovery rate of 57.3 per cent. There were 67 males and 14 females. Eighty-five per cent fell into the 20 to 40 years age bracket; the youngest was 15, the oldest 61 years. Of the 81 wounds, 4 were made by an icepick, 1 was a gunshot wound, and the remaining 76 were knife wounds.

CLINICAL STATUS ON ADMISSION

In the appraisal of cardiac wounds, the condition of the patient on admission to the hospital must not be used as an index of the severity of the injury. Although it reflects the gravity of the situation, the clinical status on

From the Surgical Service of Harlem Hospital, Department of Hospitals, New York.

TABLE I.—CLINICAL STATUS ON ADMISSION TO HOSPITAL

Condition of patient	20 patients D.O.B. (no surgery)	61 patients operated on			Total
		No. of pericardial wounds	No. of myocardial wounds Auricular	Ventricular	
In extremis B.P. o/o Pulse absent	14 (70%)	o	1 (died on table)	6 (3 survivals)	7
Deep shock B.P. o/o Pulse barely perceptible	6 (30%) Pulse perceptible in 3 cases	3 (25%) (1) Hemopneumothorax (2) Tension pneumothorax, multiple wounds of chest (3) Laceration internal mammary; sucking wounds of chest; tension pneumothorax (died)	4 (2 survivals)	23 (10 survivals)	27
Moderate shock Systolic B.P. <80 Pulse, perceptible, rate and quality variable, occasionally pulsus paradoxus	o	3 (25%) (1) Large sucking wound (2) Massive hemothorax (3) Postoperative pericardial tamponade, pneumonitis	1 (survival)	12 (9 survivals)	13
Mild to no shock Systolic B.P. >80–normal Pulse, fair to good (normal)	o	6 (50%) (1) Pulmonary embolus 14th day (died) (2) Age 61 yrs. urinary suppression due to sulfa therapy, 11th day (died) (3) (4) (5) (6) Not remarkable All recovered	o	2 (1 survival) 1 patient walked into hospital and then collapsed	2

Summary:
7 patients in extremis and apparently hopeless were operated on; 3 lived, 4 died
30 patients in deep shock were operated on; 14 lived, 16 died
16 patients in moderate shock were operated on; 13 lived, 3 died
8 patients in mild to no shock were operated on; 5 lived, 3 died

admission does not necessarily indicate the prognosis, since we have had moribund patients survive operation and recover, and patients in fair condition die before surgery could be instituted. It should be emphasized from our experience that an extremely grave clinical status on admission should never suggest that the case is hopeless.

In all our cases of heart injuries, pericardium included, the clinical picture common to all was shock. Analysis of the admission status of the 81 cases in our series permitted the establishment of the following categories: (1) In extremis, apparently moribund. Blood pressure o/o, pulse nonperceptible. (2) Deep shock. Blood pressure o/o, pulse barely perceptible. (3) Moderate shock. Systolic blood pressure below 80, pulse perceptible, rate and quality variable, occasionally, pulsus paradoxus. (4) Mild or no shock. Systolic blood pressure 80 to normal, pulse fair to good (Table I).

Of the 20 patients who died before surgery could be done, 14 or 70 per cent were moribund on admission, and the other 6 or 30 per cent were in deep shock.

Of the 61 patients who were operated on, 7 seemed moribund. They were all operated upon incident to which 3 lived and 4 died (1 died on table during operation—auricular wound without tamponade).

Thirty patients were in deep shock on admission. After surgery, 14 lived, 16 died. Sixteen patients were in moderate shock on admission; after surgery, 13 lived and 3 died. Eight patients were in mild or no shock on admission; after surgery, 5 lived, 3 died.

Of the 61 patients operated upon, 50 per cent of the 12 with pericardial wounds and 98 per cent of the 49 with myocardial wounds were in shock on admission. Seven or 14.2 per cent of the patients with myocardial wounds seemed moribund, yet with prompt treatment, 3 of this group were saved.

Less than 30 per cent of the patients were unconscious on admission, but in many there was a notable incidence of cerebral disturbance. Many patients were belligerent, mentally confused, unco-operative, maloriented. Dyspnea and air hunger were common findings, but engorged, swollen neck veins were recorded in less than 20 per cent of the cases.

DIAGNOSIS

The incidence of cardiac wounds at Harlem Hospital over the years 1938 to 1951 was approximately 7 per cent of the penetrating chest wounds (50 to 135 per year) and 3 per cent of the total penetrating and nonpenetrating chest wounds (50 to 225 per year). This incidence, vastly higher than in most general hospitals, creates an alertness and an awareness in the resident and in the visiting staff that is invaluable for the recognition of these injuries.

All wounds over and immediately around the cardiac area are suspicious, and if with reasonable certainty they may be considered penetrating, the diagnosis of cardiac injury must be entertained. On the other hand, there should be an awareness that wounds inflicted beyond the cardiac perimeter may also damage the heart, wounds above as well as below the clavicle, also wounds in the axilla. We have not encountered a heart wound inflicted through the posterior chest wall (Fig. 1).

Along with the site and likelihood of penetration, the presence of the shock syndrome previously referred to weighs heavily in favor of a diagnosis of cardiac injury (98 per cent of patients with myocardial and 50 per cent with pericardial wounds were in shock). In tamponade, distant, muffled, or barely audible heart wounds are compelling signs and a rather common association. In only 8 cases of tamponade was there a record of engorged, swollen neck veins, a sign that theoretically should be observed with greater frequency since it is an expression of the increased venous pressure associated with tamponade.

As aids in diagnosis, we have not taken venous pressures, nor have we done aspiration of the pericardium. It has been stated by Bigger (4) that the fluoroscopic finding of decreased or apparent immobility of the cardiac shadow is absolutely diagnostic of tamponade. We have found that roentgenograms of the chest are just as valuable when combined with other findings.

En route to the operating room, chest roentgenograms were routinely made, quickly, and with a negligible disturbance of the patient, an important consideration. In 46 of the 52 patients who had tamponade at operation, the cardiac shadow was enlarged beyond controversy (Fig. 2).

If there were sufficient clinical data to suggest heart injury our decision was forthright —exploratory thoracotomy. Over the time span of this series, in only 6 cases were patients explored by thoracotomy for cardiac injury with negative findings, and all recovered without morbidity.

THE CARDIAC WOUNDS

The knife wounds of the myocardium, auricle, and ventricle were in all instances cleanly cut, incised type lacerations about ¾ inch on the average, but ranging from ¼ to 1½ inches in length. With pericardial tamponade, it was evident that bleeding at the wound site was under some degree of control, but subsequent to the decompression of pericardiotomy, brisk bleeding invariably resumed. There was, of course, the exceptional case in which the wound found sealed with clot did not bleed after decompression. In this series, there were 3 cases with this finding, one a wound of the pulmonary conus, a ¾ inch laceration which appeared to be so well sealed that the surgeon decided not to disturb it, and left it unsutured. This occasioned criticism at the time, but the subsequent course was uneventful, and the patient left the hospital 37 days after admission. The other 2 wounds found sealed with clot were of the right ventricle and intraluminal. In these clot was evacuated, and the wounds sutured.

The icepick wounds were of the puncture variety, but not innocuous; 2 were well defined lacerations. They all developed tamponade, bled profusely, and required suture.

It has been impossible from our observations to give with validity, reasons for the development or lack of development of pericardial tamponade. It has been logical to presume from our findings that the size and patency of aperture of the pericardial wound, and its relationship to the myocardial wound predisposed to a mechanical state, that either entrapped blood in the pericardium or lost it extrapericardially.

The anatomical location of the wounds in the 61 cases that came to surgery was: In the pericardium, 12 cases (5 with myocardial

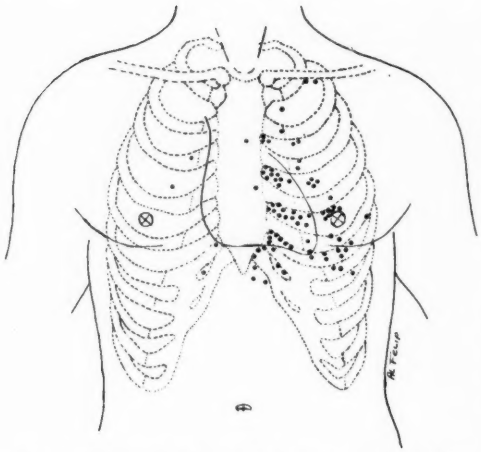


Fig. 1. Diagram showing sites of wounds on skin surface in relation to heart topography.

nicks). In the myocardium 49 cases—3 in the right auricle, 3 in the left auricle, 20 in the right ventricle, and 23 in the left ventricle.

These wounds have all been recorded as intraluminal. There were 7 cases of laceration of coronary vessels: 2 involving the anterior descending branch of left coronary, both near the apex; 1 involving a smaller branch of the left coronary; 4 involving branches of the right coronary (Fig. 3a and 3b).

There were 3 wounds that penetrated both left and right ventricles through both chambers and walls, from anterior to posterior surface of the heart. (All recovered.)

There were no wounds involving the atrioventricular septum.

CARDIAC TAMPONADE

The pathological physiology of pericardial tamponade. Herz-tamponade, a term introduced by Rose in 1884 and meaning increased intrapericardial pressure, is brought about by the incarceration of blood in the pericardial sac. It is the basic pathology in wounds of the heart. In a purely mechanical sense, it has positive value in that it might reduce or stop bleeding from a wound of the heart. Beyond this, in the creation of a pathologic physiology which can be fatal if it persists, tamponade is a nocuous phenomenon which must be relieved if the organism is to survive.

Acute tamponade by bringing about cardiac compression does two things:

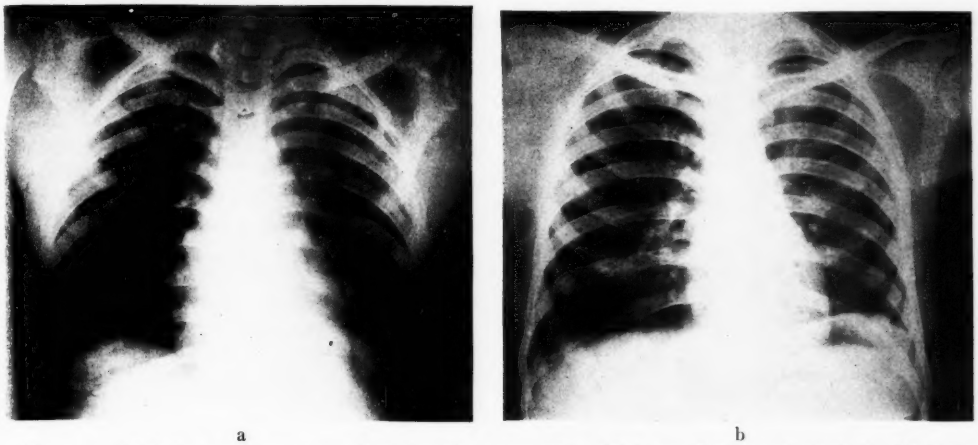
1. On the arterial side, it decreases cardiac output and induces a fall in blood pressure, and this without arteriolar dilatation entering the picture; it is the almost identical mechanism at work in circulatory failure due to acute hemorrhage. The coronary arteries usually fail to fill properly, and there is a reduction in the minute output of the heart.

2. The immediate effect of increased intrapericardial pressure is on the auricles and the great veins. On the venous side, there is an increased atrial pressure which may rise considerably above the average norm of 31 to 33 millimeters of water as established by Cournand and by Stead. There is a reflected rise in venous pressure (cavae and jugulars) detectable by manometric readings, and sometimes clinically manifest in distended engorged neck veins.

The filling of the right heart depends in the normal state and, for that matter, also in the abnormal state of increased intrapericardial pressure, on the maintenance of a pressure differential between the cavae and the right atrium. The flow of blood into the right chamber is directly proportional to this pressure differential. In the course of a progressing tamponade, the pressure differential may be diminished and finally abolished, resulting in a cessation of flow. Such an occurrence would be synonymous with cardiac arrest and circulatory failure. It is almost certain, however, that death would supervene before this physiological terminus was reached.

The organism does attempt to compensate for a rise in atrial pressure by increasing venous pressure, effecting this through venous constriction and the volume pooling of blood on the venous side. This may, however, be only briefly effectual, depending on how rapidly blood accumulates and pressure rises in the pericardial sac.

Cooper and associates found that it was possible in the experimental animal with pericardial tamponade to increase venous pressure by the intravenous administration of physiological saline. They found that a dog could withstand a greater intrapericardial pressure when given a rapid intravenous in-



a b

Fig. 2. a, Admission roentgenogram: enlarged cardiac shadow, no hemothorax; stab wound in third left interspace 1 midclavicular line. Admission status: blood pressure 0, pulse imperceptible. Operative finding: ¾ inch laceration of left ventricle, intraluminal. b, Discharge roentgenogram, 1 month after operation: note diminution in size of cardiac shadow, return to normal; left leaf of diaphragm elevated. On discharge, patient asymptomatic.

usion with subsequent increase of blood volume. To quote: "From a theoretical standpoint, it appears that improvement in the circulation under those circumstances would depend on the ability of the pericardium to stretch and allow adequate cardiac filling with the increased venous pressure. In our dogs, such stretching appeared to occur, and the increased pericardial pressure was more than compensated by increased venous pressure."

In the human, the fibrous pericardium is a dense unyielding membrane. Nevertheless, distention does occur in response to a sudden effusion, up to a point, and the pericardium gives way even more to chronic distention with large collections of fluid. It is, therefore, logical to presume that, by simulating results in the experimental animal, the intravenous administration of fluid could be employed with benefit in the acute pericardial tamponade of heart wounds. Our clinical observations indicate that it is a measure of considerable value for the improvement of the circulatory status in the early phase preliminary to the institution of definitive therapy.

Incidence and nature of tamponade in patients operated upon. As an operative finding, tamponade occurred in 52 of the 61 patients who came to surgery (Table II).

Of the 7 patients with pericardial wounds without tamponade, 6 were admitted in good condition, 1 in shock.

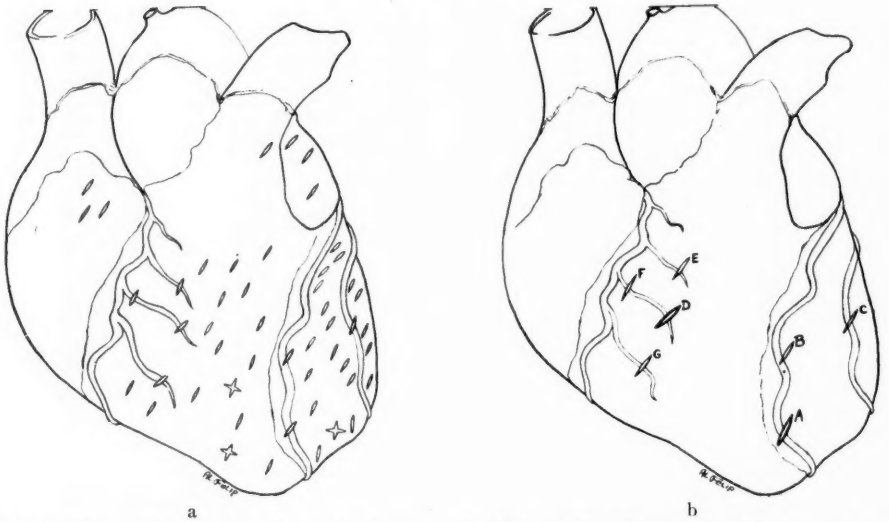
The patient with the wound of the left auricle without tamponade was admitted *in extremis*, had a massive left hemothorax, and died on the operating table from uncontrollable hemorrhage.

The wound of the right ventricle simulated almost identically, in findings and course, the left auricular wound.

Basically two types of hemopericardium were encountered.

1. The enlarged bluish hemorrhagic sac, tense and exhibiting no cardiac pulsations, and with little or no seepage of blood at the site of the pericardial wound (which sometimes had to be sought as it was not immediately evident). Associated with this type of sac was an insignificant hemothorax, if any.

2. An enlarged sac, quasipulsatile, or with an absence of pulsations, discharging a constant or intermittent flow of blood from the pericardial wound. This type of sac providing its own decompression by the ejection of blood might well explain the survival of patients who reached the operating table with a tamponade of long duration, such as 4 to 10 hours, in our series.



a b

Fig. 3. a, Diagram showing sites of wounds of myocardium; 4 pointed star indicates wounds through both chambers. b, Sites of wounds involving coronary vessels; *A* and *D* died on table; all others recovered.

In practically all cases, the major content of the sac was clotted blood. It is this finding that questions the efficacy of, although it does not preclude, aspiration as a decompressive measure. We have noted that fluid blood was present in greater quantity in patients who reached the operating room very soon after the injury.

It is unequivocal that a progressive acute tamponade will inevitably be fatal if unrelieved. It has been axiomatic, therefore, to relieve tamponade at the earliest possible moment. There has been the feeling that time is of the essence, and that few patients survive beyond 1, 2, or perhaps 3 hours. Time is of the essence, but a study of our 52 surgical cases gives information about the duration of tamponade in relation to survival that is not only enlightening, but surprising to say the least (Fig. 4).

If tamponade can last 9 to 10 hours with survival, it is conceivable that it can last longer, and perhaps go on to resolution of the tamponade and healing of the heart wound. This brings to mind the historic cases of Tourby and Cabriolanus, proved at autopsy, of heart wounds that healed without therapy. A prolonged tamponade with survival, indicative of a stabilized or stabilizing traumatic pathologic condition, would also more logically invite the consideration of conservative management by aspiration. In our series, all patients who had had tamponade of 3 hours or more successfully underwent operation.

TABLE II.—SITES OF CARDIAC INJURY IN PATIENTS OPERATED UPON, WITH INCIDENCE OF TAMPONADE AND MORTALITY

Location	Total No. of cases	No. developing tamponade	No. of deaths	No. not developing tamponade	No. of deaths	Total No. deaths	Total No. recoveries
Pericardium	12	5	1	7	2	3	9
Right auricle	3	3	1	0	0	1	2
Left auricle	3	2	1	1	1	2	1
Right ventricle	20	19	9	1	1	10	10
Left ventricle	23	23	10	0	0	10	13
Totals	61	52	22	9	4	26	35

SIGNIFICANT FINDINGS IN AUTOPSY PROTOCOLS OF 20 PATIENTS WHO DIED BEFORE SURGERY

1. All the cardiac wounds but 1 were inflicted transpleurally with an associated laceration of pleura and lung. All but 2 of the lacerations were peripheral and apparently innocuous in themselves.

2. Three patients had associated penetrating wounds of the chest and abdomen that might have been contributory to the fatal outcome in so far as hemorrhage is concerned.

3. Two patients had injuries that in themselves could have been rapidly fatal due to hemorrhage: (a) laceration of internal jugular vein; (b) laceration of femoral vessels.

4. It could be concluded in 12 cases that death came from rapid and voluminous exsanguination because of: (a) absence of tamponade; (b) size of heart wound; (c) massive left hemothorax.

5. One case was of a gunshot wound of the heart and lung associated with massive hemothorax and tamponade.

6. Three patients gave evidence of a distended pericardium with abundant fluid blood, also left hemothorax. These are the patients who could conceivably have died from tamponade or a combination of tamponade and blood loss.

It seems to be a valid impression that blood loss in stab wounds of the heart is never too great to the outside but instead is usually within the chest cavity (concealed hemorrhage).

ASSOCIATED INJURIES AND SIGNIFICANT PATHOLOGICAL FINDINGS IN THE 61 SURGICAL CASES

1. In 52 or 85.2 per cent, the cardiac wound was inflicted transpleurally. The likelihood of injury to the heart through the pleura-free pericardial triangle of Voinitch is slight because of its small size and location.

2. Hemothorax or hemopneumothorax was present in 44 or 72 per cent.

3. Nine patients had sucking wounds of the thorax.

4. Three patients had bilateral penetrating wounds of the thorax (1 lived, 2 died).

5. There were no cases of serious lung lacerations.

6. Three patients with associated abdominal wounds, i.e., discrete, apart from chest wounds, required both thoracotomy and laparotomy. All recovered.

7. Three patients had associated lacerations of the diaphragm due to chest wounds. Two required laparotomy as well as thoracotomy. One died.

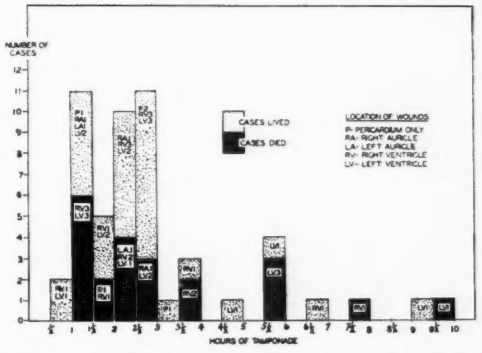


Fig. 4. Distribution of 52 proved cases of cardiac tamponade according to time intervals between injury and operation, with mortalities in each group.

8. Subcutaneous emphysema was significant in only 5 cases.

9. In 1 case of a paraplegia, the result of a stab wound of the neck injuring the cord, the patient recovered.

10. Seven patients had associated multiple lacerations of the neck and extremities.

11. Two patients had severe head injuries (severe concussion, fractured skull); both died.

SURGICAL MANAGEMENT

Presurgical measures. The presurgical treatment is the prompt management of shock, a shock incident to blood loss or cardiac tamponade or both. The nervous basis of shock, pain, psychic and reflex factors, though present, is minimal in therapeutic significance at this time.

Routinely a rapid intravenous infusion of physiological saline, plasma, or both was started in the hope of increasing venous pressure to counteract the rise in atrial pressure due to tamponade.

For the hypoxemia, invariably present, administration of oxygen improved the respiratory, and indirectly, the circulatory status. Morphine once administered routinely is no longer used. We have been convinced that by its depressant action, it adversely affects respiration in the shock patient.

Certain emergency, often life saving measures were performed at this stage, such as: (1) The immediate temporary closure (by

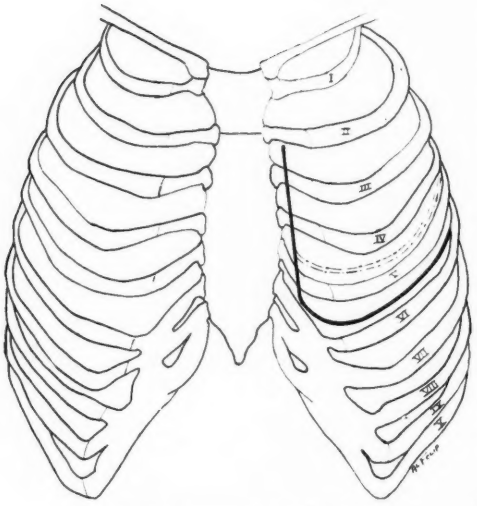


Fig. 5. The intercostochondral incision.

suture) of sucking wounds. Débridement at this stage was unimportant, as toward the end of operation, all such wounds were reopened, débrided, and resutured. (2) Syringing aspiration of air from the chest cavity after wound closure which is, in our experience, a measure of considerable prudence, one that may sometimes be life saving. It gives an immediate decompression of the existing pneumothorax with improvement of the respiratory status. (3) Hemostasis of all accessible wounds.

Anesthesia. In the unconscious patient surgery often was initiated without anesthesia, the patient receiving oxygen from the machine with a face mask. Occasionally, procaine infiltration was used and proved valuable. When the patient reacted to pain, inhalation anesthesia had to be given, nitrous oxide and oxygen administered briefly to good advantage, and then a shift made to ether or cyclopropane.

It should be noted that a few of the earlier cases of the series, due to emergency factors, were done by open cone ether given by inexpert intern anesthetists. This procedure is tenable only when a unilateral pneumothorax exists. Control of the open pneumothorax created by thoracotomy is essential to avoid the immediate ill effects of a mediastinal flutter. This was effectively done by the old device of Muller, seizing the collapsed lung by sponge forceps, drawing it into the wound and holding it firmly to stabilize the mediastinum.

Because of the hypoxic state of the patient and in consideration of difficulties and dangers attendant to rapid atraumatic intubation, endotracheal anesthesia with its obvious advantages was precluded from general use. Instead we employed a closed circuit with a tightly fitting face mask. The disadvantage of this method is the inability to aspirate secretions from the tracheobronchial tree and to maintain a free airway as well as the grave danger of regurgitation of gastric contents into the bronchi.

All this predisposed to a high incidence of pulmonary complications, atelectatic and aspiration morbidities. At the end of operation, much effort was given to catheter aspiration of the trachea and bronchi. Bronchoscopy, used with frequency in the postoperative period, was never required at this stage.

Operative technique with comments. We are of the opinion that cardiac wounds regardless of location, are best dealt with through a left transpleural thoracotomy, so planned as to afford adequate exposure—transpleural, because practically every cardiac wound is inflicted transpleurally and this approach permits an appraisal of the overall traumatic damage in the chest which may bear heavily on the ultimate prognosis. Furthermore, in line with our plan of surgical therapy which at the conclusion of cardiorrhaphy strives to make a wide open pericardial sac confluent with the left pleural cavity, it is mandatory that we pursue the transpleural route.

In all but 1 of the 61 cases, the approach was through the left chest. Right thoracotomy used in 1 case gave insufficient exposure and had to be supplemented with transverse sternotomy.

Prior to 1948, cardiac wounds were handled on the general surgical service. Except for basic principles, there was little uniformity in technique. Thoracotomy always entailed the removal of segments of the third, fourth, and fifth ribs and their cartilages, creating a per-

manent defect of the caseous cage. On occasion, the surgeon, anticipating the likelihood of attachment of pericardium or heart to the soft tissues of the wall, sutured lung to the periphery of the defect, interposing a buffer between parietes and heart. In a few instances, this included marsupialization of a lung laceration which was present. The value of this maneuver was questionable.

In the follow-up, quite a few patients displayed concern over the exposed, vulnerable, and annoyingly pulsatile heart, and had developed a protean symptomatology referable to the defect that could be interpreted only as a cardiac neurosis. One sensitive fellow contrived a protective prosthesis that he wore at all times. On the other hand, it was amazing to learn how completely free of symptoms most patients were, particularly as to pain, discomfort, and palpitation.

In 1948, with the purpose of preserving intact the osseous cage, it was decided to use an intercostochondral incision, a modification of the Spangaro incision. Thoracotomy was achieved by using the fourth or fifth intercostal spaces, carrying through from the sternal edge to the midaxillary line; the necessary vertical exposure was gained by section of the third, fourth, and fifth cartilages close to the sternal border. The internal mammary vessels were ligated and sectioned at the extremities of the vertical wound. With the introduction of a rib spreader, a more than adequate exposure was obtained. This incision is the least shocking of all approaches, not an unimportant consideration at this time, and permits the most rapid entry into the chest since cartilage can be cut by scalpel as easily as soft tissue (Fig. 5).

In opening the pericardium in tamponade, the greatest care must be exercised to avoid injury to the heart itself. Ballance has stressed the fact that with collections of fluid in the pericardial sac, the heart cannot move backward, but its apex and ventricles are crowded forward, sometimes abutting on the anterior pericardium by the fluid which collects in major quantity in the posterolateral pouches. It is our habit to open the pericardium its entire length from its base on the diaphragm to the upper narrower part surrounding the great vessels. With release of tension due to evacuation of clots and fluid blood, bleeding may be briskly activated. As soon as the pericardium is widely open, the surgeon, plunging his hand into the sac, should seize the heart, "an organ which has an enormous capacity to withstand mechanical insult," apply digital compression on either side of the wound or over the wound but never in the wound itself (Fig. 6).

Fig. 6. Digital occlusion and fixation of wounds for suture.

For torrential bleeding where immediate control is imperative if the patient is to survive beyond the table, nothing meets the situation more satisfactorily than the Sauerbruch grip for temporary occlusion of the venae cavae (gripped between the ring and middle fingers of the left hand). This, however, can be maintained only briefly without danger of fibrillation of heart muscle or complete cessation of cardiac activity (Fig. 7).

In ventricular suture, a fairly large, half circle, preferably atraumatic needle with No. oo or ooo silk has been used, with sutures passing down to, but not through, the endocardium, and tied snugly but not tightly enough to strangulate. Sutures should be so placed as to avoid compromising the coronary circulation by occlusion of main trunks or branches of the coronary vessels inadvertently. A coronary vessel that is cut must, of course, be ligated just proximal to the injury, preferably with a suture ligature of fine silk.

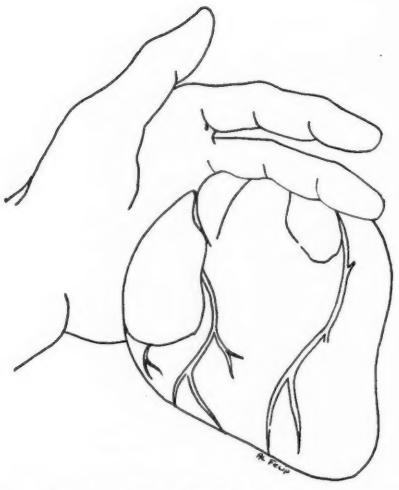


Fig. 7. Sauerbruch grip for occlusion of venae cavae.

The apical stay suture of Beck is valuable but is also dangerous because of the friability of heart muscle and the thinness of the myocardial wall sometimes encountered at the apex. In 3 cases the suture did cut through inflicting troublesome wounds that required repair.

We have encountered heart muscle of varied texture—sometimes firm, sometimes soft and friable. In 1 patient who died on the table, the muscle was so soft that successful suture was impossible. In place of the apical suture, we have found that manual luxation of the heart as it is brought forward will in most instances adequately expose the posterior surface for inspection and suture.

Suture of the auricle, because of the thinness of its walls inherent in the paucity of its muscular fibers, presents a special problem. For satisfactory suturing, preliminary wound occlusion is imperative since bleeding is so constant and copious from these wounds.

Digital compression is not recommended for occlusion of the auricular wound. More effective is the use of a Trendelenburg type of rubber shod clamp, when practicable, or the simple grasping of wound edges by Allis clamps, crisscrossing them for approximation of wound edges. Fine silk, impregnated with vaseline and applied as interrupted sutures tied with inordinate care, is our preferred method of closure. Although it is desirable to avoid suture of the endocardium for fear of mural thrombosis, in 1 case through-and-through suture was the only expedient for successful closure. Recovery was uneventful.

A reinforcing layer of sutures should always be placed over the line of primary closure, the ends of sutures left long for fixation of oxycel or gelfoam as further hemostatic protection.

In our earlier experiences, the folly of pericardial closure with the almost certain sequel of a postoperative pericardial collection and the frightful danger of a septic pericarditis was noted. To prevent this, the pericardium was left widely open to drain into the left pleural cavity. In those few cases in which the surgeon could not quite control his enthusiasm to close the pericardium, dangerous postoperative collections occurred and presented a formidable problem in postoperative management.

In 1 case done quite recently, it was necessary for me to reoperate for relief of a progressing postoperative collection which could not be safely managed by aspiration. Although the pericardium had been left partially open, the edges had become attached to the heart and sealed off the sac, resulting in a large collection in the posterolateral pouches and posteriorly in the oblique sinus (cul de sac of Haller or left atrial bursa). After complete evacuation of fluid from all the pericardial recesses, the left leaf of the pericardium was excised in part, and then sutured to the left mediastinal pleura in such a manner as to establish permanent confluences of the cavities. The patient improved postoperatively with miraculous promptness. Recovery was then uneventful. Because of its significance, the case report is appended.

Case 1. E.G., Chart No. 50-7488, a 34 year old colored female, was admitted on April 16, 1950 in profound shock, blood pressure 20/0, pulse imperceptible, conscious, and with severe dyspnea. Two chest wounds, one through left breast, nonpenetrating, the other penetrating in the fifth intercostal space at the midclavicular line. The patient received saline infusion, plasma, and oxygen immediately. Within a half hour after admission, blood was started. Thoracotomy was performed through an intercostal incision in the fifth space, with section of third, fourth, and fifth cartilages. Massive peri-

cardial tamponade presented with intermittent ejection of blood from the pericardial wound. With release of tamponade, a pulsatile projection of blood occurred from a 1 inch laceration of left ventricle, about 2 fingers above apex. The wound was intraluminal, and bleeding was copious. It was successfully sutured with No. 000 Deknatel. The pericardium was partially resutured and an opening of about an inch left near the apex for drainage. Underwater air drainage of left chest was performed and the chest was left dry.

On April 17, 1950, the first postoperative day, fluid was present in the left lung field and enlargement of heart shadow. The following day examination showed an enlarged heart shadow and displacement to the right. Electrocardiogram taken on this date was read as showing evidence of pericardial effusion and tamponade. On April 24, 1950, the eighth postoperative day, the heart shadow was even larger and fluid was present on left chest which was loculated in appearance. Pulse was small, rate 120 to 130 and dyspnea extreme.

On April 25, 1950, the patient was taken to the operating room. The chest was re-entered under local anesthesia, and oxygen was given by machine with tightly fitting face mask to control respiration. The cut edges of the pericardium were sealed to the myocardium, and the pericardial sac was ballooned up with a serosanguineous collection. The leaves were detached from the myocardium and the fluid evacuated. The left atrial bursa was evacuated by wringing the heart forward and upward. From this potential (normally) sac, at least 20 to 40 cubic centimeters of fluid was evacuated. Excision of a medial portion of the pericardium, avoiding injury to the phrenic nerve, and suture of the medial leaf to left mediastinal pleura appeared sufficient at the table to ensure confluence of the pericardium and left pleural cavities. Both air and fluid drainage of the left chest was done by Foley catheter. The patient was returned to the ward and from then on showed remarkable improvement.

On May 3, the patient showed atelectasis of left lower lobe and partial left upper lobe was bronchoscoped with aspiration of bronchi. The condition cleared up, and by May 16 both lungs were clear, the heart shadow was reduced in size to practically normal, the patient was out of bed, ambulatory. She was discharged on June 9, 1950 with electrocardiographic suggestion of both myocardial damage and pericardial involvement.

Prior to the closure of the thoracotomy wound, the following routine has been diligently followed and is highly recommended:

1. Both pleural and pericardial sacs are left dry with removal of fluid blood and clots.

2. Reinspection and ligature, if needed, of the internal mammary vessels and intercostals are carried out. Prior to this series, a case was lost from failure to doubly ligate the internal mammary. There should be hemostasis of the cut edges of the pericardium.

3. Meticulous hemostasis of the thoracotomy wound is performed. Oozing from the thoracotomy wound explains many a postoperative pleural collection.

4. A Pezzar or Foley catheter is inserted into the chest at the second interspace in the midclavicular line for underwater drainage. This provides continuous aspiration of air, and is prophylactic against the build-up of a tension pneumothorax.

5. All stab wounds of the chest, temporarily closed, are reopened, débrided, and resutured without drainage.

6. Instillation into the chest of sulfonamides, penicillin, and streptomycin. From 1938 to 1945 the sulfonamides were used; from 1945 to present, penicillin and streptomycin.

7. Finally, the thoracotomy wound is closed tightly without drainage of either pleura or pericardium.

POSTOPERATIVE COMPLICATIONS

Postoperative pleural collections of fluid. Serosanguineous collections were fairly common in the immediate postoperative phase, an incidence of over 50 per cent. However, they were seldom of such quantity as to become a disturbing morbidity. In only 3 cases did infection develop, and then the empyema was handled satisfactorily by closed drainage, aspiration, or by both.

Postoperative pericardial collections. There were 6 cases in which partial closure of the pericardium was done. Five developed postoperative collections that responded to repeated aspirations, the sixth patient was reoperated upon on the eighth postoperative day and recovered. Aspiration of a postoperative pericardium must not be taken lightly. It is not altogether comparable to aspiration of a chronic effusion in the pericardium.

Of the 2 in whom complete closure was done, one had an uneventful course with gradual resorption of the fluid and the other died from unrelieved tamponade associated with infection.

It has been observed in many cases that the enlarged cardiac shadow may last a week to

10 days before there is a significant reduction in size. This is of little importance as long as there is no indication of the presence of cardiac compression.

Postoperative hemorrhage from cardiac wound. This was proved to have occurred in 3 cases. Following operation, the state of shock persisted despite repeated transfusions of blood. Deterioration of the clinical state occurred in 24 to 48 hours after surgery. All these patients died.

Respiratory obstruction. In at least 5 of the fatalities on the operating table, there is reason to believe that respiratory obstruction due to mucus and/or aspiration of vomitus was more responsible for the exitus than any other factor.

In spite of a diligent postoperative catheter aspiration of the trachea and bronchi, pulmonary complications occurred nevertheless. There were 2 cases of massive collapse, one of each lung. Thirty per cent had scattered areas of atelectasis, lobar and lobular, but only 5 cases progressed to pneumonia and pneumonitis. There was no case of lung suppuration or abscess. Two cases of pulmonary infarction occurred, both associated with wounds of the right ventricle. Only 1 patient died from what was diagnosed as a fatal pulmonary embolus. This could have been a cardiac death.

Tension pneumothorax. There were 2 cases of tension pneumothorax, 1 with fatality. This death was avoidable because functioning underwater drainage was not efficiently maintained.

Sepsis. No case of sepsis occurred nor of mediastinitis.

Infection of stab wounds. Infections occurred in 12 stab wounds; 2 gave a prolonged morbidity due to necrotizing infections. Infection of mild degree occurred in 9 operative wounds.

Extrathoracic complications not related to the heart injury were: 2 cases of delirium tremens (1 death); 1 case of renal suppression due to sulfonamide medication (died); 1 case of dermatitis gangranosa—with recovery; 1 paraplegia due to deep neck wound with cord injury; 1 cerebrovascular accident (embolus?) —died.

MORTALITY

Twenty of the 81 patients died before surgery could be done. Of the 61 patients operated upon, 26 died and 35 recovered, a recovery rate of 57.3 per cent (Table III). Of the 26 surgical mortalities, 17 occurred within 72 hours from the onset of surgery. Eleven of these were deaths on the operating table, the result of a complexity of factors, namely: (1) uncontrollable hemorrhage; (2) hypoxemia, anoxemia; (3) anesthesia; (4) shock; (5) technical surgical failures.

The other 6 deaths were due to shock, recurrent or continuing hemorrhage from incompetently sutured cardiac wounds, tension pneumothorax, massive hemothorax, postoperative pericardial tamponade, and pulmonary edema.

In the remaining 9 deaths after 72 hours, the following complications and associated injuries had a decided bearing on the demise of the patients: (1) renal suppression associated with sulfonamide medication; (2) uncontrollable delirium tremens; (3) head injuries—concussion and skull fracture; (4) associated abdominal visceral injuries; (5) pulmonary complications, as massive atelectasis, pneumonia, pneumonitis, pulmonary infarction; (6) cardiac complications, as tachycardias, arrhythmias, fibrillations; 3 coronary occlusions (2 incident to laceration of vessels; 1 associated with left ventricular laceration).

Despite the magnitude of the task and many adverse factors confronting the surgeon, 11 deaths on the operating table seems to us inordinately high. Since 1948, heart wounds have been assigned to the thoracic surgical service and have been handled by men thoroughly conversant with the problem and well trained in thoracic procedure. At the same time there has been an improvement of emergency facilities and in the anesthesia situation, all of which has been reflected in recent statistics from 1948 to 1951. During that time, in 15 patients admitted, 3 died without surgery, 1 died on the operating table, and 1 died on the fifth postoperative day. The other 10 patients recovered. There has been recovery of the last 9 consecutive cases following primary cardiorrhaphy with a minimum of complications, and an average hospital stay of 31

days as compared with the previous average of 75 days.

COMMENT

This report of 81 cases creates a perspective by which the problem of penetrating wounds of the heart emerges as an understandable unity with well defined pathological and clinical facets. The core of the problem is acute pericardial tamponade, which, by its development, contains hemorrhage, prevents a voluminous blood loss, and thereby saves life in the early phase. But tamponade is a two-edged sword, and if the build-up of intrapericardial pressure continues unabatedly, death will ensue from cardiac compression. The evidence indicates that lethal tamponade may occur relatively rapidly; also that tamponade may be prolonged for as much as 10 hours or more without fatality. The latter indicates that the build-up of lethal pressure was delayed, stopped, or controlled in one of two ways, or in both. (1) By the reduction or cessation of hemorrhage from the cardiac wound—by blood clot or wound closure itself. To quote Ballance, "wounds of the heart under some circumstances do not allow the continued escape of blood. They close and heal as do some wounds of the great arteries." (2) By decompression through the constant or intermittent ejection of blood from the pericardial wound.

The evidence of long duration of tamponade suggests not only that aspiration has a logical basis for use as definitive therapeutic procedure, but also that, in the isolated case, the tamponade may become stabilized and go on to resolution with healing of the cardiac wound and recovery of the patient. A few such cases have been reported, which were verified by autopsy findings. Even in the period before operative interference on the heart, according to Georg Fischer's statistics, 85 per cent died and 15 per cent recovered.

We are opposed to aspiration as definitive therapy, except when the surgical setup, including personnel, is inadequate for the task of pericardiotomy and cardiorrhaphy. The element of practicability looms high against aspiration when it is recognized by our findings that the major content of the sac is unfailingly clotted blood. But more important is the consideration of the late results that seem likely with blood clot remaining and with fibrin deposition on the serous sac over heart and the large vessels at the base. Adhesions seem to be inevitable as in a clotted hemothorax, and certainly there would be some incidence of adhesive pericarditis as a sequel. Even in our series, with clots removed, there has been evidence that adhesions do form since we have noted 5 cases of adhesive pericarditis, 2 of which had increased venous pressures, and indications of the constrictive syndrome. In a recent report, Dr. Maguire of Louisville, operated upon a patient for constrictive pericarditis 6 months after the aspiration treatment (10). It is likely that as time goes on, a greater number of cases of constrictive pericarditis, sequel to the aspiration treatment will be reported.

TABLE III.—ANALYSIS OF DEATHS IN 61 PATIENTS OPERATED ON WITH REFERENCE TO SITE OF WOUND AND TIME OF DEATH

Location	No. of cases	Total No. deaths	Time of death			
			During surgery	Within 24 hrs.	Within 24–72 hrs.	After 72 hrs.
Pericardium	12	3	0	0	1	2
Right auricle	3	1	0	1	0	0
Left auricle	3	2	1	0	0	1
Right ventricle	20	10	4	2	0	4
Left ventricle	23	10	6	1	1	2
Totals	61	26	11	4	2	9

From 1938 to 1951, each successive year has given a lowered incidence of infection, i.e., sepsis, septic pericarditis, empyema, and wound infection due in great part to the effectiveness of chemotherapy and the antibiotics. Careful preoperative preparation and meticulous surgical procedure likewise played a significant role in this record.

SUMMARY AND CONCLUSIONS

1. A report has been made of 81 penetrating wounds of the heart and pericardium. Twenty patients died before surgery could be instituted, and 61 were operated on with a recovery rate of 57.3 per cent.

2. All patients with myocardial wounds who reached the operating table, with the

exception of 2 who died on the table, had a significant pericardial tamponade.

3. Pericardial tamponade has been present for as long as 10 hours without fatality.

4. Practically all heart wounds were inflicted transpleurally so that two problems were simultaneously posed; viz., the penetrating wound of the heart, and the penetrating wound of the chest with lung laceration, hemothorax, pneumothorax, or hemopneumothorax. A transpleural surgical approach was therefore in order for an overall assessment of the thoracic injuries and for appropriate therapy.

In conclusion, we are convinced that surgical management is preferable to conservative management by aspiration. Pericardiotomy and primary cardiorrhaphy is a sound effective procedure, which is capable of effecting a high recovery rate and less likely to result in adhesive pericarditis with the ominous danger, in some cases, of development of the constrictive syndrome. Our findings suggest, however, that aspiration may on occasion be thoroughly effective as definitive therapy. There is no question of its value preliminary to surgery.

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MALIGNANT POLYPS OF THE RECTUM AND SIGMOID

Therapy Based upon Pathologic Considerations

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DESPITE the voluminous literature regarding intestinal polyps these neoplasms remain an enigma to those confronted with their diagnosis and treatment. Although studies reveal differences in some academic aspects there is general agreement that such lesions are precancerous and that their frequency is clinically significant.

That all polyps of the colon should be extirpated is unequivocal. However, the therapy for carcinoma arising in polyps, including the so-called malignant adenoma, has often been conflicting, indecisive, or even neglected in many of the reports regarding this subject.

The purpose of this study is to present the follow-up observations on a series of carcinomas of the rectum and lower sigmoid colon arising in polyps. An attempt is made to establish an individualized plan of therapy based upon histopathologic considerations. Only those lesions which were treated locally (fulguration and implantation of radon seeds) and were considered by the surgeon to be clinically benign (not frankly ulcerating carcinoma) are included. In all instances multiple biopsies of the lesion, or complete removal, afforded adequate tissue for histologic study and evaluation. Instances of polypoid carcinoma without evidence of benign polyp in their structure and those of familial polyposis were discarded. Only those tumors conforming with the above criteria and occurring in the rectum, or that portion of the lower sigmoid which would necessitate abdominal perineal resection, were considered. It is believed that certain carcinomas arising in polyps are adequately treated by local means without minimizing the chances of cancer cure. This site acts as a proving ground for this assumption, since radical excision of the rectum with colostomy has social and economic disadvantages.

Thirty-five cases fulfilling these criteria were collected from the pathologic records of the Cleveland Clinic during the 10 year period, 1939 to 1949[1]. These comprise 10 per cent of all polyps submitted for pathologic examination during that interval. In 14 cases, follow-up studies were inadequate, leaving for consideration 21 cases with observations ranging from 2 to 10 years.

TERMINOLOGY AND PATHOLOGIC CONSIDERATIONS

The term "polyp" has received criticism because of its lack of specificity, since literally a polyp is a pedunculated nodule of neoplastic or other tissue found on mucous membranes (7). In order to circumvent such ambiguity, we have adopted the descriptive adjectives "adenomatous" and "papillomatous" to indicate the neoplastic character of the lesion. An adenomatous polyp is characterized by mature, mucus-secreting cells of the goblet type forming regular glands resembling those of normal colonic mucosa. Their outer surface is smooth or lobulated and consists of one or more layers of epithelial cells. The papillomatous variant is more complex in structure and is distinguished by frond-like projections covered by tall columnar epithelial cells, more often of the nonsecretory type and forming irregularly shaped glands with frequent involutions (Fig. 1). Either type may be pedunculated depending upon its location. Those lesions situated upon a mucosal fold are more likely to become pedunculated because of the more direct force applied by peristalsis. Between the glands of both variants is a variable quantity of connective tissue corresponding to the lamina propria of

From the Cleveland Clinic and the Frank E. Bunts Educational Institute.

[1]The majority of these patients were treated by Dr. Thomas E. Jones, deceased.

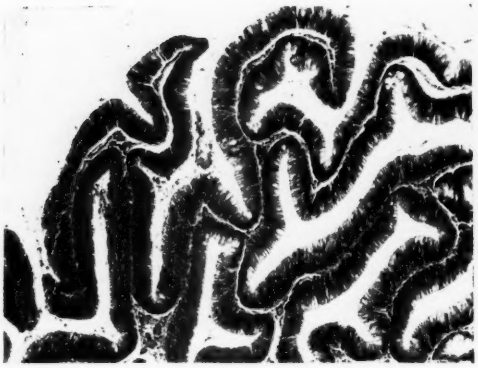

Fig. 1. Frond-like projections of outer surface of papillomatous polyp. Many cells are of the nonsecretory type. ×50.

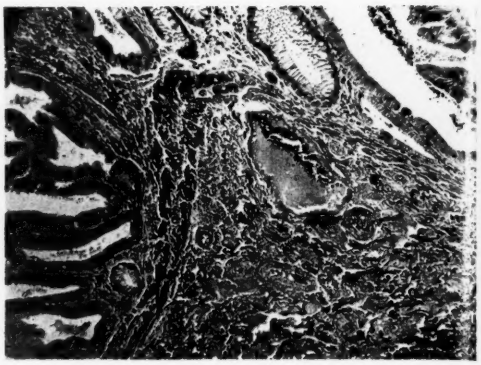

Fig. 2. Section through stalk of polyp demonstrating large vascular spaces in submucosa beneath muscularis mucosa. ×50.

the colon. Frequently this layer is the site of inflammatory changes and hemorrhage. Beneath the lamina propria lies the muscularis mucosa. Its distribution depends upon the presence or absence of a pedicle. In the sessile growths it is noted as a rather uniform band of smooth muscle beneath the lamina propria although, on occasion, it is seen to project into this layer tangentially. The pedunculated polyp reveals the muscularis mucosa arranged parallel to the long axis of the stalk but not present in the frond-like projections of the papillomatous variant. In the pedunculated form of polyp it is important to realize that the submucosa of the underlying colon with its attendant lymphatic and vascular channels is carried into the stalk for varying distances (Fig. 2). Explanations as to the different appearances of these polyps have been based upon pathogenetic features. Binkley and Sunderland (9) have suggested that the adenomatous variant arises from the glandular epithelium of the colonic mucosa, whereas the papillomatous type arises from the surface epithelium. However, Helwig, after careful serial and step sections of polyps, could find no histologic criteria supporting this contention. He was of the opinion that the papillomatous variant represented a later stage in polyp formation. The frequent recognition of both variants in the same polyp tends to support his observations. Another type of polyp encountered in the intestine is the diffuse papillary adenoma, or villous tumor. It is felt that this lesion does not represent a distinct histologic entity but is a papillomatous polyp par excellence, deriving its size and configuration from the wide field of its origin.

One frequently encounters the statement that certain polyps probably never become malignant; this gives the impression that another morphologic type exists (3, 8, 9). These observations have been made on purely clinical grounds. Histologically there are as yet no recognizable features of polyps to support such a contention. Hellwig, Willis, and others have stressed the inability of predicting the outcome of these benign lesions from histologic study.

Before describing the criteria employed in the classification of carcinoma arising in polyps, attention must be directed to a change observed in the benign polyp which is frequently misinterpreted as carcinoma. This lesion has been described under various names, the most widely used being "polyp with atypism" or "polyp with dysplasia." Such a polyp is characterized histologically by pseudostratification of cell nuclei, frequent mitoses, elongated, columnar epithelial cells devoid of secretory activity and having cytoplasms which stain deeply basophilic with hematoxylin and eosin (Fig. 3). However, the absolute criteria for the diagnosis of malignancy is lacking in this lesion. Another misleading feature of pedunculated polyps is the

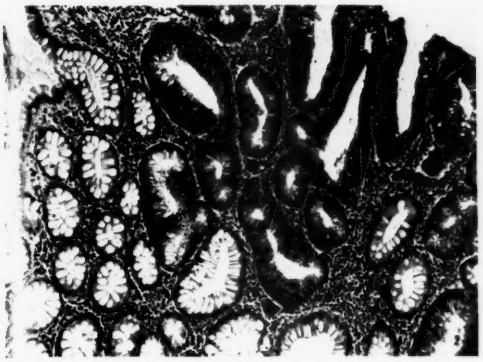

Fig. 3. Section of polyp demonstrating dark staining, mucosecretory cell type of dysplasia arising in adenomatous polyp. Normal glands are evident at the left. ×50.

apparent presence of glands beneath the muscularis mucosa which might well be interpreted as invasion but which in reality is artefact due to a plane of section through a twisted pedicle (Fig. 4).

Grossly, a polyp has no definitely consistent features indicative of malignant change. Ulceration has been encountered seven times more frequently in the malignant polyp (3) and induration also has been described as a feature of the malignant polyp (4). However, these changes may occur in benign lesions as the result of reactive inflammatory changes with fibrosis and hemorrhage.

The microscopic characteristics of carcinoma in polyp have been well presented by Swinton and Warren (11) and consist of: (1) anaplasia characterized by variation in the size of cells and their nuclei, atypical mitoses and prominent nucleoli; (2) irregularity characterized by true stratification, intraglandular budding, and loss of cellular and nuclear polarity, and (3) invasion. According to these authors the presence of any two establishes a diagnosis of malignancy.

In classifying carcinomas arising in polyps, we have adopted descriptive terms rather than numerical grades. Three types are recognized: (1) carcinoma in situ, (2) superficial carcinoma, (3) invasive carcinoma. This classification leads to a better understanding of the lesion and avoids the intangible subjectivity of numerical grading.

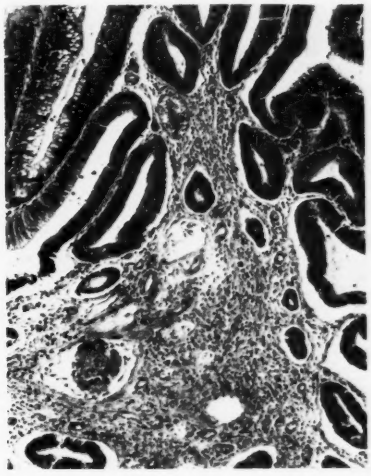

Fig. 4. Occurrence of nonmalignant glands in stalk due to artefact. ×50.

Carcinoma in situ (Figs. 5 and 6) is characterized by anaplasia and irregularity limited to the glandular elements of the polyp without evidence of invasion. This represents perhaps the earliest recognizable carcinomatous change in the polyp and is analogous to Bowen's disease of the skin and carcinoma in situ of the uterine cervix.

Superficial carcinoma (Figs. 7 and 8) exhibits not only the cellular atypia and irregularity described but also reduplication of lumina and invasion of the lamina propria. There is no extension into the muscularis mucosa, lymphatic or vascular spaces. Oftentimes definite distinction between carcinoma in situ and superficial carcinoma is difficult and requires repeated sectioning.

Invasive carcinoma (Figs. 9 and 10) reveals invasion of the muscularis mucosa and/or vascular and lymphatic channels. The differentiation of superficial carcinoma from the invasive type is simplified by the presence of a desmoplastic tumor stroma in the latter. When such stroma is found in lesions not demonstrating muscularis mucosa invasion, additional sections often demonstrate such invasion. This desmoplastic feature has heretofore received little attention in this type of lesion but it is significant that it has been found in all lesions of the invasive type. Although a

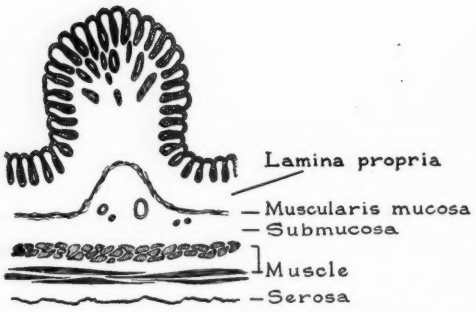

Fig. 5. Schematic representation of carcinoma in situ arising in polyp.

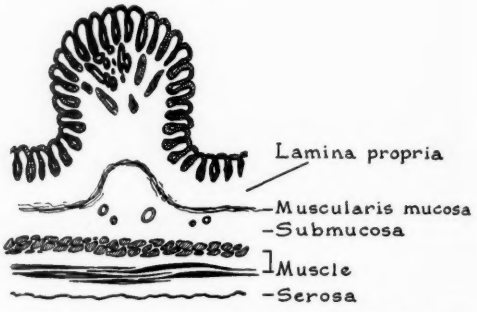

Fig. 7. Schematic representation of superficial carcinoma arising in polyp.

situation might arise in which exhaustive study has established no invasion, the presence of such a stroma in the presence of atypical epithelium should be considered indicative of invasive carcinoma because of the limitations associated with the sectioning and orientation of these lesions.

RESULTS

In this study of 21 cases, the incidence of carcinoma arising in polyps was most frequent in the fifth and sixth decade. The age range was from 25 to 85 with an average of 60.2 years. This coincides with the results of others (McLanahan and associates, Helwig, Castro and associates) and occurs 10 to 15 years later than the age incidence of benign polyp (1). There is no apparent predilection in the location of these lesions in the various quadrants of the rectum or sigmoid. Although the most frequent site of carcinoma was peripherally and distally in the polyp, in 2 cases the lesion was in the midportion. Fourteen cases were considered as either carcinoma in situ or superficial carcinoma arising in polyp, and 7 as invasive carcinomas. All patients have survived their disease from 2 to 10 years; 13 surviving 5 years or longer. Two patients died of carcinomatosis due to a second lesion situated in another portion of the colon and 1 died of cirrhosis of the liver 10 years after removal of a superficial carcinoma arising in polyp (Fig. 11 and Table I). There were 5 patients having superficial carcinoma in which there were recurrences or incomplete removal. None of these recurrent lesions demonstrated malig-

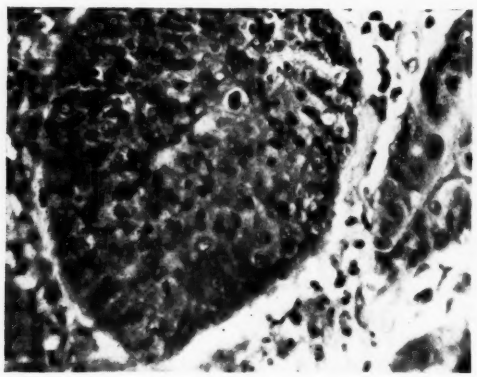

Fig. 6. Photomicrograph of gland demonstrating carcinoma in situ. Basement membrane intact. Anaplasia and irregularity are distinct. ×350.

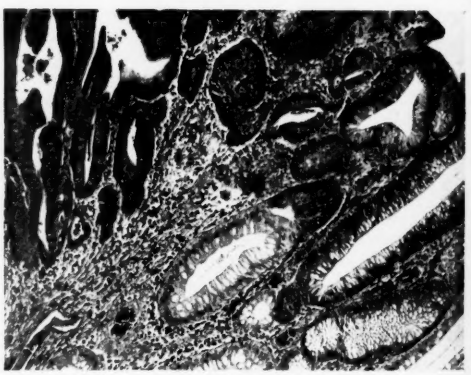

Fig. 8. Photomicrograph of superficial carcinoma arising in polyp. Nests of neoplasm in tunica propria and reduplication of lumina. ×50.

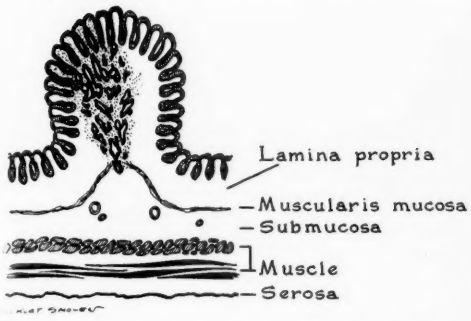

Fig. 9. Schematic representation of invasive carcinoma arising in polyp.

ancy. There were 3 instances of recurrence in incomplete removal in the invasive group. All subsequent studies revealed invasive carcinomas. Two patients in the superficial carcinoma group had abdominoperioneal resection and 5 years after local therapy because the lesion was uncontrolled. There were no recurrences in any other patient of either group 1 year after local therapy.

TREATMENT AND DISCUSSION

Of significance in this study is the fact that all 14 patients with carcinoma in situ or superficial carcinoma arising in polyp survived their disease, 11 being followed for 5 or more years. Although the group is small the results are more significant if incorporated with those of McLanahan and his associates (25 cases), Swinton (10) (22 cases), and Castro and associates (9 cases) who reported follow-up studies of from 5 to 7 years of comparable lesions without fatality attributable to the initial disease. With the addition of the 11 cases with more than a 5 year follow-up in this series there are 67 such lesions treated locally which have been clinically cured.

TABLE I.—TYPES OF CARCINOMA ARISING IN POLYP

Types of lesion	Superficial or carcinoma in situ No.	Invasive carcinoma No.	Total No.
Total	14	7	21
Benign recurrence	5	0	5
Recurrence as invasive	0	3	3
Died of disease	0	0	0
Later radical surgery	2	0	2
Died of other cause	2	1	3
	(Cirrhosis, carcinomatosis due to second lesion)	(Carcinomatosis due to second lesion)	

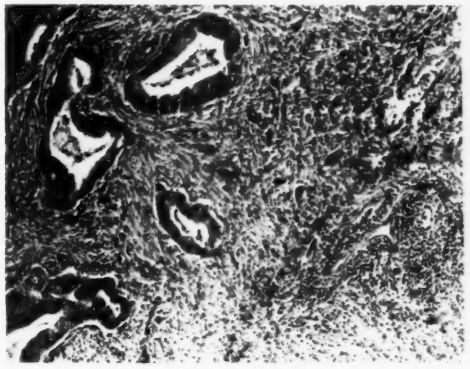

Fig. 10. Photomicrograph of portion of invasive carcinoma in polyp demonstrating desmoplastic tumor stroma. ×50.

It is believed, therefore, that polyps demonstrating carcinoma in situ or superficial carcinoma located within 5 inches of the dentate line can be safely treated by complete local removal and destruction of the base by radon seeds or coagulation. Patients with diffuse lesions who cannot be successfully treated by local means are subjected to abdominoperineal resection or a pull through procedure depending upon the level of the lesion.

All 7 patients demonstrating invasive carcinoma in polyp have survived and are at present free of clinical evidence of their disease. However, it must not be construed from the

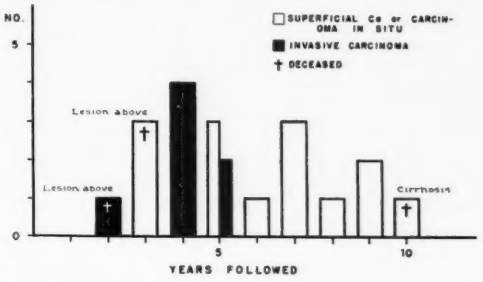

Fig. 11. The number of patients and the years observed following polypectomy.

results of such a small group that this is the treatment of choice for such lesions. It may be assumed that the neoplasms were confined to the superficial portion of the bowel allowing for destruction in their entirety by local therapy but one cannot be guided by assumptions as to the proper treatment of malignant disease if success is to be obtained. Realization that metastases may occur many years after the resection of carcinoma of the colon and that the invasive carcinoma anatomically has gained access to submucosal lymphatics and vessels makes radical surgery mandatory for low lying invasive carcinomas arising in polyp. However, in practice one is often compelled to treat such lesions (as in this series) by local means because of the clinical limitations of extreme age and debility.

The histologic studies in this series were limited to polyps of the rectum and lower sigmoid colon. There are, however, certain clinical considerations worthy of mention pertaining to carcinomas arising in polyp located 5 inches or more above the dentate line. It has been the practice to treat sessile polyps in this location by resection with anastomosis since frozen section diagnosis of sessile lesions at the time of colotomy is inaccurate and the resection of the colon with present techniques and antibiotic drug therapy is as safe as colotomy alone.

Lesions on a long pedicle 5 inches above the dentate line are removed by colotomy. Anatomically, the muscularis mucosa rarely ascends into the tumor bearing areas; therefore the chance of encountering invasive carcinoma in such a polyp would appear rare. These pedunculated lesions are more easily oriented than the sessile type allowing for more accurate frozen section diagnosis. It has been the practice to examine frozen sections of pedunculated lesions at the time of colotomy. Inspection of several well chosen sections through the stalk of such lesions has been satisfactory in establishing invasion which, if present, necessitates colon resection. Such frozen section examination, however, has the disadvantage of eliminating the most important area from permanent section evaluation if it is found that the frozen section diagnosis is not conclusive.

It is not pertinent to present, in this analysis, arguments for or against the histologic diagnosis of preinvasive carcinoma. Those who believe that the diagnosis of carcinoma can be made only when invasion is present should offer little objection to this outline of conservative therapy. The only differences encountered are those of academic rather than practical significance.

For the success of such a plan of treatment there must be close co-operation and a clear understanding of the problem between surgeon and pathologist. It is the surgeon's responsibility to provide tissue, well oriented and adequate, whereas the pathologist must attempt to establish the type and extent of a given carcinoma in a polyp. The most satisfactory specimen is the entire lesion so that practically all areas may be properly evaluated. If the lesion is large and cannot be removed *in toto* for pathologic study, we have found the use of multiple biopsies satisfactory.

With the previously mentioned plan of therapy it is felt that adequate local cancer treatment may be applied to the rectum and lower sigmoid colon for certain lesions which might be considered amenable only to radical surgery. The occurrence in this study of 2 patients having developed carcinomatosis from lesions located elsewhere in the colon reemphasizes the extreme importance of thorough investigation for lesions in other portions of the intestine. The periodic examination of all patients having polypectomy is mandatory.

SUMMARY AND CONCLUSION

Due to the incidence and relationship of the benign polyp to carcinoma of the colon and rectum the intestine is considered to be a most important site for cancer detection and prevention.

The histologic criteria for the diagnosis of carcinoma arising in polyp consist of: (1) anaplasia characterized by variation in the size of cells and their nuclei, atypical mitoses, and prominent nucleoli, (2) irregularity characterized by true stratification, intraglandular budding, and loss of cellular and nuclear polarity, and/or (3) invasion.

A descriptive classification of carcinoma arising in polyp is presented. Malignant

change limited to the glandular structures of the polyp without evidence of invasion of the lamina propria is considered as carcinoma in situ. A lesion demonstrating invasion of the lamina propria of the polyp but without invasion of the muscularis mucosa or lymphatic and vascular channels is termed superficial carcinoma. The presence of invasion of muscularis mucosa and/or lymphatic and vascular spaces is characteristic of invasive carcinoma. The occurrence of a desmoplastic tumor stroma in the invasive carcinomas has been a valuable histologic aid in establishing this degree of malignancy. Carcinoma in situ and superficial carcinoma *arising in polyp* in the rectum and lower sigmoid colon are treated locally. Fourteen patients in this series with such lesions have been followed for 2 to 10 years without recurrence of their disease. Invasive carcinomas arising in polyp are treated by abdominoperineal resection except in the aged or debilitated, or in the patient who is a poor surgical risk.

The therapy of carcinomas arising in polyp above 5 inches from the dentate line is briefly commented upon.

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ACUTE ABDOMINAL INJURIES

THE nature of the injury to the abdomen, with particular attention as to whether the force was applied slowly or suddenly, generally determines the pathology resulting in acute abdominal injuries.

Because of the mobility of most of the abdominal viscera, trauma applied slowly is less likely to cause rupture of a viscus than are sharp, sudden blows. A distended hollow viscus is more likely to rupture than one that is empty, while a hollow viscus which is the site of a pathologic process, such as an ulcer or a diverticulum, might be expected to rupture easily. Such a locus of a rupture is actually rare and most patients with a ruptured hollow viscus have had ruptures through normal appearing structures.[1]

Not all intra-abdominal hollow viscera are intraperitoneal and this may cause some confusion in diagnosis if not properly considered. Notably, the duodenum, the ascending colon, the descending colon, and the bladder are extraperitoneal. Not only are these structures extraperitoneal, but they are relatively fixed structures and do not move freely when force is applied. The root of the mesentery of the small intestine is also relatively fixed and is likely to be bruised from crushing injuries. Solid viscera, such as the liver, spleen, pancreas, and kidney too are moderately fixed structures, but have sufficient mobility and compressibility to tolerate slowly applied pressures.

The sudden application of pressure is more apt to cause rupture of these structures, especially if they are enlarged, than an even greater pressure gradually applied. The viscera of young people appear to tolerate trauma better than those of the older age groups.

The recognition of serious damage to intra-abdominal structures is not usually possible immediately after the accident. A severe blow to the abdomen usually causes a great deal of disturbance initially, and soreness in the abdomen is likely to persist for some time even when no serious intra-abdominal injury is present. The fact that the patient appears to recover quickly from a severe blow to the abdomen does not rule out a serious intra-abdominal injury. There are times when the patient will appear to recover from the immediate effects of trauma to the abdomen only to develop signs of visceral injury later. The most important therapeutic factor is early recognition and careful and continued follow-up observation. Even upon careful examination, an injury to the abdomen may at first show little, but within a few hours rigidity and pain may become acute enough to warrant exploration.

[1] PENBERTHY, GROVER C., and BENSON, CLIFFORD N. Injuries to the abdomen in industry. Am. J. Surg., 1947, 74: No. 3.

The time for surgical exploration must be early to be of value, for here it is decidedly better to be safe than sorry.

The presence of shock should be an index of abnormality in abdominal injuries. Adequate x-ray examination, as in all emergencies, is important and essential. Yet, the salient factors are careful clinical observation and continued study. The blood pressure, pulse rate, cyanosis, respiratory difficulty and pallor are among the common elements of good clinical study. While rupture of any hollow viscus is apt to result in peritonitis, tears of the large bowel are particularly hazardous and invariably require early laparotomy. It is worthwhile to point out that several cases have been reported in which gas escaped into the peritoneal cavity from a small opening in the colon and later caused a massive right subdiaphragmatic collection of gas, yet only a localized well walled-off abscess resulted.

The solid viscera most commonly injured in trauma to the abdomen are the liver and spleen. Rupture of either of these structures results in a severe loss of blood. Smaller tears in the liver may cause only a small loss of blood before clotting occurs. This is not usually so in a patient with splenic rupture. Even small tears in the spleen may continue to ooze blood over a long period, so that the first outstanding symptom which calls attention to the seriousness of the injury is the appearance of anemia. Larger splenic tears are more likely to present the picture of acute blood loss. Little success is obtained in repairing these small rents; it is simpler and better to remove the traumatized spleen.

Massive tears in the liver likewise result in acute blood loss. In such patients suture of the rent is usually possible, especially with oxidized cellulose or gelatine foam as supports for the suture and to aid in the prevention of extension of tearing. The use of the proper substances in conjunction with thrombin to control bleeding are of obvious importance. In massive tears of the liver, the possibility of bile peritonitis is a dangerous threat and in these patients, if there is any question of poor approximation of the torn liver, it is wise to institute drainage. It is rarely necessary to pack the rent in the liver with gauze as the absorbable substances are more effective and simpler to use.

Traumatic peritonitis can result when there is no discernible wound in the abdominal wall and this type of peritonitis is free from bacterial contamination. If the urinary bladder is injured, with leakage of its contents into the peritoneal cavity, severe peritonitis results. Bile leakage likewise causes a serious peritoneal reaction. Blood in the peritoneal cavity may be absorbed and cause little reaction, but if it clots and the fibrin holds the cells peritoneal adhesions usually can be anticipated.

Rupture of the pancreas is quite often overlooked. Small pancreatic tears may result in cyst formation; this is discovered, if at all, at some time remote from the accident. The head of the pancreas or that portion lying over the spine is most susceptible to danger from crushing injuries. It is in this portion that the ducts are larger. Injury here can result in great losses of pancreatic juice, especially so following drainage of a resulting abscess.

It must be emphasized that although the abdomen is the subject discussed, it is important to restate the paramount need for a complete examination. If the suspected abdomen is uninjured, the thorax, the skull, in fact any part of the body may be seriously damaged.

One would wish finally to emphasize the necessity for early surgical exploration of the injured abdomen, before every evidence that warrants this act is at hand, because irreversi-

ble complications may appear with unheralded speed. They can best be dealt with before their occurrence, not after they hold the center of the stage. GROVER C. PENBERTHY.

THE HUSH OF RETIREMENT

IN no other of life's professions or occupations is the preparatory period so exacting, so rigorous, so expensive or so prolonged as in medicine. The young physician in the full hybrid vigor of early practice may, it is true, look forward to retirement as something remote which will take care of itself, if he is a provident type and if proper financial dividends accrue. The simple fact, that mental training and preparation for the peace of an unoccupied mind is equally necessary, is but ill understood. For medicine is an anxious pursuit and the concerns of the moment are too engrossing to leave much leisure for the contemplation of the remote future, except perhaps in a materialistic sense. Medical men receive no training whatever in preparation for voluntary retirement or a forced detour on the road to fame.

Retirement must come. For those to whom it comes as a result of a well worked out plan, a competency suitable to the individual is usually well foreseen, but to those to whom it comes as a result of a devastating episode such as a coronary or unexpected stroke, too often the specter of the fear of dependency is riding pillion, and a needy environment, or the fear of it, is not conducive to mental peace.

The hobbies of medical men are too often of a type which are too strenuous to be projected into the years of retirement—golf, hunting, and other physical pleasures may be enjoyed for a time and, while these may have been anticipated with the keenest delight, yet they do not fill the evening hours, and ultimately satiety dogs the heels of pleasure. For those whose leisure hours were of the vigorous type and who have suddenly been arrested on the tide of life, the suspension of both work and physical pleasures leads to a frustrated, hopeless existence which is only accepted with more than a dash of angostura.

We are no longer educated in a way that permits us to develop sedentary cultural hobbies. We are becoming a nation of skilled artisans. There is in every man a skill hunger, a desire to do something better than his fellow man and our whole system of education is leading to the training which develops skill—a mere cultivation of aptitudes which we may or may not possess. This is a fine preparation for the utilitarian breakfast of life but an indigestible supper in the cultural evening. Skills are not enough! It is not enough merely to be wise in one's own work; the view is too short. The laborer is not remembered for his work, but the designers of our great churches, the preachers of our great sermons, the founders of new biological principles, the writers of our great essays—their memorials shall not depart away. Their minds are fully occupied in retirement!

There is a great economic pincers movement slowly encircling our profession and, unknowingly we are entering a great medical climacteric. With it is coming a great need for reassessment of our plans for retirement, both for those whose hopes encompass nothing more than carefree hours on the municipal golf course on the one hand, and the stately caperings of those who follow the spoor of the red carpet on the other.

While prophecy is a gratuitous folly, I believe that we of more senior years today are amongst the last of this era's confirmed, unblushing sybarites. In these days of the upsurging proletariat, vanishing cellars, mounting taxes, egalitarianism, our savings surtaxed into the limbo, there is no longer a possibility

of wealth and but little of unharried retirement. Chilled as we are by the first frosts of our coming austerity, encumbered as we are by the prospect of our ultimate regimentation, we can no longer look forward to yachts, country estates and racing stables, but we can and we must prepare for our intellectual entertainment during the years of our physical decrepitude. Nor can we escape these confiscatory governmental encroachments, dragooned as we are willy-nilly into the strictest financial probity.

On their retirement most men fulfill a natural bent to return to the vineyards of their youth, frequently with a desire to settle there; but the specter of aging kindred, outstretched palms, and strangers in the old chapel assuages such a yearning at an early date. The desire to retire to salubrious climates is a natural one and the establishment of a new home for a time is all engaging. But you do not make new friends readily after seventy and, in those that you do make, the roots are less deeply thrust. When the flood of home town letters slows as it will do to the merest trickle, an all encompassing ennui develops and the transplanted physician sells out and goes back home.

A man should retire amongst his friends. Sedentary hobbies are like friends: it is true they can be developed to a satisfying degree after retirement but they are not likely to be. Hobbies like friends should be developed as a slow process of growth through the years and something to which one can look forward as an ultimate metamorphosis from an exacting to a relaxing change of occupation. You should develop your hobby before retirement. New friends and new hobbies developed in senior years tend ultimately to cloy. There is wisdom in the old Chinese proverb, "Dig your well before you are thirsty." There can be nothing more pitiful than to watch the tired quest of a beleaguered soul searching for intellectual entertainment. It is then that one appreciates the Latin inscription on the old clock over the fireplace: *Amicitia Vincit Horas* —"Friendship Conquers the Hours."

To those in the full vigor of life, cultural preparation for such a remote contingency as retirement may seem like dribbling tears into your champagne. Yet, retirement should be prepared for and not left until it is something which is suddenly thrust upon you. Every man should have a hobby which should be developed in his youth, and nurtured through his years of activity. It should encompass both physical and mental attributes; it should be something cultural and productive in type; it should be shared with friends; it should be independent of wealth and physical decrepitudes and should be eagerly available:

> "When his youthful morn,
> Hath travell'd on to ages steepy night. . ."
> Shakespeare—*Sonnet* lxiii

Prepare for and do not resent the advent of old age. It is a privilege denied to so many!

LYON H. APPLEBY.

THE SURGEON'S LIBRARY

THE BOOK SHELF

"POOR RICHARD"

ESTHER H. VINCENT, Evanston, Illinois

ONE Sunday morning in January of 1706, Abiah Folger Franklin, of Milk Street, Boston, presented her husband, Josiah, with a new baby boy. Since the child was her sixth son and twice married Josiah's tenth, neither parent was much excited about him, but the pious father promptly carried the wailing little bundle across the street to Old South Church, where very young Benjamin Franklin was dutifully baptized—no doubt with ice cold water. Since tithing was still the custom, it was agreed that this, the tenth son, should be given unto the Lord, should become a clergyman.

Abiah was the daughter of the "godly, learned Englishman," Peter Folger, one of Nantucket Island's earliest residents, while Josiah was the sturdy descendant of a robust line of English blacksmiths. Josiah had settled, first as a dyer in Banbury, then as a candle and soap maker in Boston. Son Benjamin later affectionately described him as a man of good constitution, of medium height and well set up, a man of parts, good alike at the mechanical and the artistic. At eventide, to listen to his clear voice singing psalms to his own violin accompaniment was one of the family delights. Abiah bore Josiah 10 children, who, with the 7 he had by his first wife, made a large family group, even for that day. Both Abiah and Josiah lived active, healthy lives until they died, she at 85 and he at 89.

To support and educate a family of 17 on the meager earnings derived from soap and candle making was a bit difficult, and Ben was lucky to get what schooling he did. At the age of 8 he entered a grammar school and got along very well in reading, not so well in writing and arithmetic. This necessitated a second year of formal education, this time at George Brownell's school, where he got special tutoring. Then, since there wasn't money enough to train him for the Church, after all, Ben gave up school to enter his father's trade. The adventurous little lad found candles and soap rather dull, and, fearing that he might follow in the footsteps of the elder brother who had run away to sea, Josiah apprenticed him to half-brother James, who was running one of Boston's earliest printing shops and publishing America's first sensational news sheet, *The New England Courant*. Teen age Benjamin liked the printing business well enough, and contributed some pleasantly naive articles to the newspaper, which once were published under his name when the too daring James lost face with the Government. Benjamin now became permanently attracted by the hygienic charms of temperance and temporarily attracted by those of vegetarianism. The latter, however, appealed more from economic than from dietetic or moral persuasion, for the boy found that he could live on meatless meals for half his board money, and buy books with the other half. The following year, on his way to New York, he easily argued himself into eating the delectable codfish which the sailors caught in Long Island Sound.

After a quarrel with the sulky James, Benjamin started out secretly on an exhausting journey to New York and Philadelphia. Stormy weather and no food or sleep for 30 hours produced considerable distress. A high fever developed, which he controlled by drinking large quantities of cold water. Journey's end found him trudging a Philadelphia street with the famous three rolls of bread and being laughed at by his future wife, Deborah Reed.

He got a job with a queer, neurotic character, William Keimer, one of Philadelphia's two printers, and did so well that William Keith, Governor of Pennsylvania, suggested that he return to Boston and set up his own printing shop there. But Josiah Franklin thought the boy too young for such a venture, and so, urged by the vain promises of the unreliable Governor, Ben sailed

for London, where he arrived with little money and no prospects. However, he soon found work in a printing house and became locally famous for his industry, sobriety, talents (especially swimming), and his personal charm. After some 19 months, he returned to Philadelphia to work in the store of the wealthy Quaker merchant, Denham. Both Denham and Franklin shortly became ill, and Denham died. Franklin suffered from a very severe case of what may have been pleurisy. The time now was 1727 and Franklin was 21.

When he got well he went back to work for printer Keimer, but soon set up his own printing shop, which, in 10 years, became the most flourishing in the Colonies and had branches in other towns. In 1729 Franklin bought the moribund *Pennsylvania Gazette* and soon turned it into a highly profitable and influential newspaper. But it was *Poor Richard's Almanack*, first published in 1732, that really made his fortune. In those days almanacs were the most widely read books in America—every farmhouse kitchen had one—and "Poor Richard's" rapidly became a best seller. Its homely medical advice was one of its chief charms and is still quoted—"Early to bed and early to rise" etc. Foreign editions and numerous translations helped swell the Franklin coffers.

As early as 1727 Franklin started his "Junto," a club for the promotion of useful knowledge, which met on Friday evenings to hear original essays by the members, among whom were several young physicians, as well as the famous botanist, John Bartram. By 1743 this little group had become the American Philosophical Society.

In 1730 Benjamin Franklin and Deborah Reed Rogers were married—at common law, since Deborah's first husband had unaccountably disappeared. Deborah may have been the mother of Franklin's illegitimate son, but, at any rate, the little boy easily became a part of the family. In 2 years another son, Francis Folger, was born, only to die at the age of 4 of smallpox. This tragic event added strength to the young father's efforts to promote the general practice of vaccination. Sally Franklin, born in 1743, was inoculated when she was 3.

Vaccination had been introduced into the Colonies about 1721 by Cotton Mather and was first performed by Dr. Zabdiel Boylston of Boston. At that time Franklin was still working on his brother's newspaper and presumably did not agree with the paper's opposition to the new practice. When he went to London in later years he had a chance to talk about smallpox with Dr. William Heberden and induced the good doctor to write his famous pamphlet on inoculation, "Some Account of the Success of Inoculation for the Smallpox in England and America Together with Plain Instructions by Which Any Person May Be Enabled to Perform the Operation, and Conduct the Patient Through the Distemper," (1759). To Heberden's unsigned 8 pages, Franklin wrote a preface of 4 pages in which he identified the author and gave him due credit. Fifteen hundred copies were distributed free in Philadelphia. Many references to vaccination are scattered through Franklin's letters, and he stands among the crusaders against the pox.

In 1735 Franklin again fell victim to an acute pulmonary infection, characterized by "suppuration from the lungs." This may have been acute bronchitis, or, possibly, a lung abscess.

Along with his increasing activities, he somehow managed to give some thought to practical science, and, while he was not the first to consider the identity of lightning and electricity, he was the first to prove it, and the first to establish the concept of negative and positive electricity. His invention of the lightning rod did much to increase his prestige and his popularity, and his advocacy of electrotherapeutics in nervous disorders interested the entire medical profession. The practice of electric treatment came to be known as Franklinism. Later his papers on electricity were so well received abroad that the Royal Society of London bestowed upon him its Copley Medal, and the French king, Louis XV, wrote him a complimentary letter.

But his interest in electricity was very nearly the death of him in 1750, when he was handling an electrical apparatus and listening to the conversation of friends at the same time. He united the top wires of two large glass jars with one hand, while with the other he held a chain connected with the exterior of both jars. He felt a universal blow, coming both from within and from without, his body shook violently, his arms and the back of his neck went numb, and the hand that held the chain turned white and remained so for about 10 minutes.

Franklin's friend and fellow Junto member, Dr. Thomas Bond, was much concerned with the lack of a hospital in Philadelphia. There was no place at all to care for the sick and injured. But his efforts at obtaining the necessary subscriptions for a hospital met with scant success. He then appealed to his great and good friend, Franklin, who at once set in motion all the powers of his newspaper and of his own winning personality. As a member of the Pennsylvania Assembly he petitioned aid from the State and his bill was carried. It provided that, whenever the Hospital

was organized and the managers had secured 2,000 pounds by voluntary subscription, the Assembly would grant an equal sum. Franklin, himself, contributed 25 pounds, and the Philadelphia physicians, Lloyd Zachary and the brothers, Thomas and Phineas Bond, promised to give their services without pay. The charter went into effect on May 11, 1751—"An Hospital for the Relief of the Sick Poor of this Province and for the Reception and Cure of Lunaticks." Joshua Crosby was the first president and Benjamin Franklin the first clerk. All the early minutes of the meetings are in Franklin's hand, and his design for the hospital seal is still in use. Later, Franklin became president of the Board of Managers, continuing in office for many years. One of his pamphlets is the famous "Some Account of the Pennsylvania Hospital; from its First Rise to the Beginning of the Fifth Month, Called May, 1754."

At this time many of Franklin's friends were physicians, and many a young medical student owed to Franklin his opportunity to study abroad. Rush, Morgan, Shippen, Kuhn, and Griffits, as well as the Bonds, enjoyed his companionship, and even foreign physicians valued his friendship, dedicated their works to him, and invited him to join their societies. In 1756 he became a member of the Royal Society of London, and later received honorary degrees from Yale, Harvard, and the University of St. Andrew, Scotland.

Franklin was a "natural" in medicine, and, for a layman, his knowledge was phenomenal. In fact, many people considered him a physician and came to him for diagnosis and treatment. Even eminent physicians occasionally consulted him, and some of his medical letters and pamphlets are classics. His interests went all the way from sleep and seasickness to vital statistics, especially the death rate of foundlings and bottle-fed babies. Sir John Pringle asked him to come to England to treat his daughter. Dr. Jan Ingenhousz, physician to the Austrian Court, sought his advice before he inoculated the little princes. John Hunter based his essay on dry bellyache on Franklin's letters, and freely gave him credit.

Before most people had thought anything about the danger of handling lead, Franklin was writing to Cadwalader Evans that he believed certain mysterious symptoms were due to lead poisoning, "a metallic cause only; observing that it affects among tradesmen, those that use lead, howsoever different their trades: as glaziers, letter founders, plumbers, potters, white-lead makers, and painters." A letter written many years later to Benjamin Vaughan tells of a boyhood memory of Boston, when there was much discussion about the complaint from South Carolina that New England rum made people have an abdominal pain and lose the use of their legs and arms. It was found that the New England distilleries used lead in their manufacturing processes.

Franklin was probably the first American to sleep with his bedroom windows open, probably the first "fresh air fiend." His pamphlet on the common cold, "Preparatory Notes and Hints for Writing a Paper Concerning what Is Called Catching Colds," is a close approach to a genuine medical article. He defines a cold as "a siziness and thickness of the blood, whereby the smaller vessels are obstructed, and the perspirable matter retained, which being retained offends both by its quantity and quality; by quantity as it over fills the vessels; and by quality as part of it is acrid, and being retained produces coughs and sneezes by irritation." He believed that colds were due, not to getting the body wet (no one ever caught cold from sea bathing) but from breathing bad air. He considered that wet clothes were an advantage at sea when there was little drinking water, for soaking the body in water for many hours might relieve thirst. In a letter to Benjamin Rush, in 1773, he praises indulgence in fresh, cool air, discusses blood heat and its causes, and suggests that bathing or sponging the fevered body with water or alcohol would reduce the temperature. Franklin never lost a chance to express his views on fresh air and must have been something of a nuisance to the good folk who had been brought up on the dangers of night air, especially in "consumption." He even advocated cold air baths as less of a shock than cold water.

In 1749 he met Gout for the first time. Mild at first, the visitations became more frequent and severe as time went on. Except for the period, 1755 to 1760, when he was unaccountably free from pain, he and Gout were practically inseparable for the duration. Too seldom did he work at the printing press, take long walks over the Pennsylvania hills, and swim for 2 hours at a time in the waters of the Delaware. Too often did he accept a second helping of Philadelphia scrapple or a third slice of Lady Baltimore cake. His slender waist line vanished and he assumed the familiar shape of pudgy middle age. As "Poor Richard" he had written:

> A full Belly is the Mother of all Evil.
> Eat few suppers, and you'll need few medicines.
> Eat and drink such an exact quantity as the constitution of thy body allows of, in reference to the service of the mind.

He now attempted to reconcile his conscience by insisting that the amount of exercise should be

governed "not by the time or distance but by the degree of warmth it produces in the body."

While living in France, in 1780, he wrote to an English army surgeon that keeping his foot out of bed in the cold air apparently cured the pain during one winter, and lessened it the next. His son believed that "gout was to be drawn out by transpiration," and, having heard his father say that "perspiration was carried on more copiously when the body was naked, than when clothed," he thought that the cold air experience confirmed the doctrine. "But," Franklin adds, "this method requires to be confirmed by more experiments, before one can conscientiously recommend it."

The famous dialogue between Franklin and his tormentor was written at midnight, October 22, 1780, and begins thus:

Franklin. Eh! Oh! Eh! What have I done to merit these cruel sufferings?
Gout. Many things; you have ate and drank too freely, and too much indulged those legs of yours in their indolence.
Franklin. Who is it that accuses me?
Gout. It is I, even I, the Gout.

The following year, to one of his women friends, Franklin wrote a letter denying that excessive indulgence in sexual pleasures causes gout, as he had no gout when young.

In 1752 brother John Franklin in Boston was having a bad time due to retention of urine. On hearing of it, Benjamin immediately went to the silversmith's and gave directions for making a catheter. He sat in the shop until it was made and then posted it off. Thus was contrived the first flexible catheter known in the Colonies, although such an instrument was already used in Europe. One of his medical writings is called "Letters on Catheters."

During a London visit in September of 1758 he contracted a violent, feverish cold, and in November of the same year he had another with great head pain. The top of his head was very hot, sore, and tender, and the attacks would last from 12 to 36 hours. He became a little delirious and was "cupped" on the back of his head. He wrote to his wife that he got some relief from using the "bark" (cinchona) of which he took a good deal, "both in substance and infusion." Venturing out too soon, he had a relapse, and Dr. Fothergill "grew very angry with me, for acting contrary to his cautions and directions."

Back in New York in 1763, Franklin and daughter, Sally, took a horseback trip to New England, and, on the way, Franklin fell off his horse and was badly bruised. Later in the same year, he fell off again and this time dislocated his right shoulder.

Franklin was interested in materia medica, although he did not have much faith in drugs. But he and John Bartram were sort of pharmaceutical cronies, and in 1770, he sent Bartram "some of the true rhubarb seed," the Chinese type which had medicinal properties.

By 1773 he was suffering from a recurrent skin disease, probably scorbutic, since he was warned against eating salt meat and cheese. He consulted both Pringle and Ingenhousz, but they could not do much to help him. He went along with it for 14 years, every part of his body except his face and hands being covered with the eruption. Then he had an attack of gout, not too painful, but causing swelling of both the hands and the knees. As the swelling expanded, the gout vanished.

In 1775 his vision began to fail, but he got along very well with spectacles, although he had to use two pairs, one for reading, and one for distance. The nuisance of having to change glasses for various distances so plagued him that he happily invented bifocals. By August, 1784, however, he could hardly distinguish even large size letters.

It was in 1776, while engaged in influencing the French to make a military alliance with the young United States, that he wrote his essay, "On the Nature and Origin of Epidemic Catarrhal Fevers."

In 1779, when he was 63, he first became aware of urinary calculus. Opium gave him some relief, but also affected his appetite and digestion, and he grew very thin. He kept hoping to control the stone by diet, but he did seek help from Ingenhousz, who recommended Blackrie's solvent, a soap lye with lime water. For some reason, he would not consider surgery. Perhaps he thought such a cure worse than the disease.

While in France in 1784, Franklin was appointed by the King to head a commission to investigate mesmerism. The Parisian nobility was enthusiastically submitting itself to the "animal magnetism" of the pseudoscientist, Mesmer, who had been turned out of Vienna and Berlin for fraud. With four celebrated members of the Medical Faculty of Paris, Franklin proved the falseness of the claims.

Franklin's interest in physiology was evidently still lively, for, in July of 1787, the Rev. Manesseh Cutler from Massachusetts confided to his diary that he had been to Philadelphia and in Franklin's library had beheld a glass machine which exhibited the circulation of the blood through the arteries and veins. Red fluid from a reservoir passed into capillary tubes, branching in all directions, and then returned similarly to the reservoir, in a sort of perpetual motion.

By the time Franklin was 70, his teeth had become loose, causing him to limit his meat eating to salt beef. At this time also, he had some dizzy spells and was subject to boils. He had never used tobacco in any form and had always indulged but lightly in alcoholic drinks.

Now subject to both gout and the stone, he recalled a song heard during the old days in Philadelphia, in which was expressed the wish to restrain the passions and never to suffer from gout or stone. At 83 he said he suffered from both gout and stone, and was not yet master of his passions.

Franklin's physician now was Dr. John Jones of Philadelphia, who had taken his M.D. at Rheims and had studied in Philadelphia, London, Edinburgh, Leyden, and Paris. He wrote a book on surgery and was the first to do a lithotomy in New York, where he was professor in the Medical School. In 1780 he had succeeded Dr. John Redman at the Pennsylvania Hospital.

Franklin thought that one way of contenting himself with an undesirable situation was to compare it with a worse one, and comforted himself with the thought that he had only three incurable diseases—gout, the stone, and old age. He still delighted in books, conversation, and his own natural cheerfulness.

By 1790 Franklin had been confined to bed for a year with the stone. Large doses of laudanum deadened the pain and allowed him to enjoy reading and talking with friends. A little over 2 weeks before his death he grew feverish and had a chest pain on the left side. He had a bad cough and breathing became difficult. But these symptoms diminished about 5 days before the end. The "imposthumation" in his lungs finally burst suddenly and he threw up large quantities of matter before his strength failed him. Then a calm, lethargic state preceded death, which came about 11 o'clock on the night of April 17. He had lived 84 years and 3 months.

The immediate cause of death was lung abscess, although he had become debilitated by many years of suffering. In addition to gout and the stone, he had had several pulmonary infections, including a previous lung abscess with spontaneous recovery. His remarkable biologic endowments had brought him through many years of great public responsibility. His love of investigation coupled with his deep insight into human character would have made him a great physician. As it was he became the adopted father of the profession in America.

He bequeathed his cane of wild apple wood to George Washington, and 20 guineas to Dr. Jones.

Sixty-two years before, while still a simple printer, he had written his own epitaph.

The body of
B Franklin Printer,
(Like the Cover of an old Book
Its Contents torn out
And stript of its Lettering+Gilding)
Lies here, Food for Worms.
But the Work shall not be lost;
For it will, (as he believ'd) appear once more,
Revised and corrected,
By the Author.

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REVIEWS OF NEW BOOKS

A MONOGRAPH as complete and current as *Tumors of the Skin; Benign and Malignant*[1] must perforce serve a useful purpose. The authors give full consideration to cutaneous tumors and also to the various precancerous lesions, the multiform manifestations of the lymphoblastomas, flat nevi of all kinds, and the xanthomas. The clinical and histologic pictures of all of these conditions are described clearly and concisely and some are augmented with instructive case reports. One chapter deals with radiation physics and radiation therapy; another with surgery and plastic repair of cutaneous tumors; and all of the material is presented in terms of practical usefulness.

Entities but recently recognized, such as eosinophilic granuloma and histiocytoma, are described, and, also, the rarely encountered angiosarcoma in postmammectomy lymphedema. Most of the 550 illustrations, both clinical and histologic, are excellent. The bibliography is full and well selected. The book is printed on good stock and is well indexed. The authors have achieved their purpose admirably. The work is an excellent source book and should be well received.

HERBERT RATTNER.

THE one volume textbook on *Physical Medicine and Rehabilitation for the Clinician*[2] is well written and gives the fundamentals and some of the techniques that are used in the rehabilitation of many types of disabled individuals. The book is divided into 4 major sections dealing with: (1) therapeutic applications of physical agents and procedures, (2) diagnostic applications of physical agents and procedures, (3) clinical aspects of physical medicine and rehabilitation, and (4) fundamentals of anatomy, therapeutic exercise, and physiology as related to physical medicine and rehabilitation. The various chapters are written by specialists in their respective fields who deal with most of the common types of diseases and injuries. Basic principles, experimental studies, clinical applications, and technique for both diagnosis and treatment are considered and described. Physical medicine and rehabilitation for many of the severe types of disabilities such as those found in muscular and neuromuscular, circulatory, and various traumatic pathological conditions are considered.

This book should be of interest and practical value to the general practitioner as well as to other physicians in various specialties. Further, therapists in various phases of rehabilitation will find this book very enlightening and result in better understanding of the scope of one of the fastest growing specialties, physical medicine and rehabilitation.

LOUIS B. NEWMAN.

IN *The Mode of Action of Anaesthetics*[3] T. A. B. Harris has presented an extremely interesting volume. The correlation of the physiochemical properties of the respective anesthetics with their physiological activities is the basis for the scientific practice of anesthesiology. By presenting the known and hypothesized actions of the anesthetics now in use and by logical inference utilizing them to explain the physiological changes which we observe, the author has done much to develop this approach.

Both fundamental facts and clinical observations are presented in a clear and unusually readable style. One can hardly fail to acquire a better organized view of the comparable mechanisms of anesthetic action, and how, by these considerations, proper clinical management must be guided.

The actual pattern of presentation is highly systematic, progressing from a consideration of the effects of narcotic drugs upon unicellular organisms, through a consideration of the effect of anesthetic drugs upon individual mammalian cells, and finally reaching a study of their sequence of action upon the organs of the body.

The large section devoted to a most enlightening analysis of the pharmacological actions and deleterious side effects of anesthetics is one of the most excellent in this book. Seldom is such a mass of data covering such a wide field so rationally arranged. Such subjects as the actions of curare and the use of hypotensives are well covered demonstrating the wide scope of this book.

Certainly, in summary, any individual who desires to understand the rationale of clinical anesthesiology, with the interest of more than a mere technician, will be sure to enjoy and profit from this volume.

THOMAS KING LAMMERT.
RALPH M. TOVELL.

THE volume *Surgical Practice of the Lahey Clinic*[4] consists of 963 pages of concentrated clinical papers, many of which have been published recently by the members of the staff of the Lahey Clinic. Some of these have been recently revised. There are excellent sections on thyroid disease, tumors of the neck, all types of abdominal surgery, carcinoma of the breast, neurosurgery, and anesthesia. This

[1] TUMORS OF THE SKIN; BENIGN AND MALIGNANT. By Joseph Jordan Eller, B.S., M.D., and William Douglas Eller, M.D. 2nd ed. Philadelphia: Lea & Febiger, 1951.

[2] PHYSICAL MEDICINE AND REHABILITATION FOR THE CLINICIAN. Edited by Frank H. Krusen, M.D. Philadelphia, London: W. B. Saunders Co., 1951.

[3] THE MODE OF ACTION OF ANAESTHETICS. By T.A. B. Harris, M.B., B.S., D.A., F.F.A. R.C.S. Baltimore: The Williams & Wilkins Co., 1951.

[4] SURGICAL PRACTICE OF THE LAHEY CLINIC. By Members of the Staff of the Lahey Clinic, Boston. Philadelphia, London: W. B. Saunders Co., 1951.

collection of papers compares favorably with the high standard of publications maintained by this group of distinguished surgeons.

In a brief review it is obviously impossible adequately to describe this book. One would wish to say, however, that it is highly recommended to everyone in surgical practice since in many fields the individual authors are recognized as authorities on the subject which they are presenting.

THOMAS C. DOUGLASS.

THE volume *Surgery of Peripheral Nerves*[1] is the result of a wide experience gained soon after the last war in the treatment of peripheral nerve injuries. It is a rare combination of excellent line drawings and photographs which are used to demonstrate the anatomy of all of the major peripheral nerves of the extremities. For example, there are 17 photographs of the surgical incisions which are used to expose the injured nerves; both incorrect and correct incisions are illustrated and the difference between poorly placed and properly placed surgical incisions is clearly shown. The incisions which the author advocates are well tested, are physiologically sound in their application and obviously produce superior results. The discussion is limited and the story is told by pictures or diagrams. Many points of controversy are handled by simple statements which are based upon the wide and successful experience of the author.

The book includes a very brief chapter on the principles and technique of nerve surgery. In fact, it is so brief it could well be expanded for the benefit of the uninitiated. The remainder of the volume deals with anatomical groups of individual peripheral nerve lesions. The anatomical drawings in themselves make this an extremely valuable and worthwhile volume for both medical students and surgeons.

HARVEY S. ALLEN.

THE 400 page monograph *Tonsil and Allied Problems*[2] by Roy H. Parkinson of San Francisco is all that its jacket claims, and expresses so well. To quote, "The author presents an accurate, painstaking, and comprehensive study. It includes minute embryology, histology and anatomy, clinical applications and techniques." The illustrations are outstanding and the style interesting and readable.

Seven years have been spent on this study of the lowly tonsil and related subjects, the lowly tonsil upon which so many general practitioners seem to consider themselves qualified to operate, with little or no surgical training. This book would serve a most useful purpose were everyone attempting the operation, with inadequate preparation, to read, at least, the 78 page chapter on technique. The author draws not only upon his own nearly 40 years of medical experience but has consulted some 50 specialists in various fields from all sections of the country. The extensive reference lists at the close of each chapter testify as to the thorough coverage of the literature.

Certain controversial subjects of special interest are considered from various angles, among these being poliomyelitis and tonsillectomy, tonsillectomy and the singing voice, and rheumatic fever and the tonsil. The allied problems considered are too numerous to mention but include temporomandibular arthralgia, branchial fistula, glossopharyngeal neuralgia, and benign and malignant regional tumors. The book closes with reflections, calling attention to the facts that the tonsillectomy is not without danger, and that a careful study of the patient's general condition should be made before deciding on an operation, facts known so well by all, but sometimes forgotten in familiarity-bred contempt.

Graduate students and residents in otolaryngology will find this an excellent text, and both specialists and nonspecialists will use it to advantage for ready reference or review. Dr. Parkinson merits our thanks.

ALICE K. HALL.

THE small volume *Manual de radiologia clinica*[3] has been written expressly for the general practitioner and students of medicine. It is based on the practical and the modern, omitting the purely theoretical and the impractical complicated methods. The author expounds not only the opinion of native authorities but has garnered from abroad foreign literature the best and the most pertinent. As a result, a clear, valuable, and authoritative work has been forthcoming, one which is bound to be helpful particularly to those for whom it was intended.

The book contains 245 pages in 8 point type or less and despite its paragraph brevity on many issues it covers the entire field of radiologic technique and diagnosis. The book is generously illustrated with views and sketches aptly designed to bring out methods and positionings. The normal, abnormal, and pathologic are contrasted so that the examiner may easily differentiate and arrive at a diagnosis. In this manner the human body is surveyed in an orderly and appealing manner.

The simple, clear, and forceful style hurdles language boundaries recommending the reading of the volume by those of other tongues who may be interested in radiology. Their trouble will be well rewarded.

STEPHEN A. ZIEMAN.

FOR years the German editions of the text *Roentgen-Diagnostics*[4] have been considered preeminent in the field of roentgen diagnosis. The medical profession, especially the radiologist, is tre-

[1] SURGERY OF PERIPHERAL NERVES. By Emil Seletz, M.D., F.A.C.S., F.I.C.S. Springfield, Ill.: Charles C Thomas, 1951.

[2] TONSIL AND ALLIED PROBLEMS. By Roy H. Parkinson, M.D., F.A.C.S. New York: The Macmillan Co., 1951.

[3] MANUAL DE RADIOLOGIA CLINICA. By Dr. Juan Jose Quezada R. Tacubaya, Mexico: Impreso por la editorial, 1951.

[4] ROENTGEN-DIAGNOSTICS. By H. R. Schinz, W. E. Baensch, E. Friedl, and E. Uehlinger. First American edition (based on the fifth German edition). English translation arranged and edited by James T. Case, M.D., D.M.R.E. Vol. 1, Part 1, Skeleton. New York: Grune & Stratton, 1951.

mendously indebted to Dr. James T. Case for arranging and editing this, the English translation of the fifth German edition. The complex nature of the task performed is only partially revealed when one considers the scope of the subjects which are included. In this first volume there is detailed discussion not only of x-ray defraction in relation to bone structure but also genetics as applied to bony anomalies.

The English translation of the fifth German edition will appear in 5 volumes. The first two will consider the skeleton; the third, the thorax; the fourth, the intestinal tract; and the fifth, gynecology and urology. The English volumes will follow the appearance of their German counterpart after approximately a 6 month interval.

In volume one the first 200 pages are devoted to the basic principles of the roentgen ray, including fine structure analysis and general roentgen symptomatology of normal and pathological skeletal structures. Fractures, including the mechanism, healing, operative procedures, and complications are very adequately discussed. Aseptic necrosis, inflammatory bone diseases, and hereditary diseases with bony changes are also presented in this volume. The last section on hereditary diseases, written by Professor Dr. A. Cocchi, is exceptionally well documented from the genetic standpoint. A very generous bibliography is included at the end of each section.

All of the roentgenograms are positive, photographically speaking. The detail is excellent, the reproductions of the numerous charts, line drawings, and photographs are all extremely well done. The paper, printing, and binding are all of excellent quality.

This excellent translation of the revised and enlarged fifth edition of Schinz will assuredly fill a gap in the library of the non-German reading roentgenologist. The volume is highly recommended to all who desire a detailed background as well as a thorough text in roentgen diagnosis.

R. Burns Lewis.

BOOKS RECEIVED

Books received are acknowledged in this department, and such acknowledgment must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interests of our readers and as space permits.

Hippocrates: On Intercourse and Pregnancy. An English Translation of: On Semen and On the Development of the Child. By Tage U. H. Ellinger, Sc.D., M.A. With an Introduction by Alan F. Guttmacher, M.D. New York: Henry Schuman Inc., 1952.

Prescription for Medical Writing; a Useful Guide to Principles and Practice of Effective Scientific Writing and Illustration. By Edwin P. Jordan, M.D., and Willard C. Shepard. Philadelphia and London: W. B. Saunders Co., 1952.

The Clinical Use of Fluid and Electrolyte. By John H. Bland, M.D. Philadelphia and London: W. B. Saunders Co., 1952.

Fractures and Joint Injuries. Vol. 1, 4th ed. By Sir Reginald Watson-Jones, B.Sc., M.Ch. Orth., F.R.C.S., F.R.A.C.S. (Hon.), F.A.C.S. (Hon.). Baltimore: The Williams & Wilkins Co., 1952.

Atlas of Gynecologic Pathology; Color Film Library and Descriptive Manual. By Anthony V. Postoloff, M.D., and David H. Nichols, M.D. Baltimore: The Williams & Wilkins Co., 1952.

Management of the Newborn. By Arthur Hawley Parmelee, M.D. Chicago: The Year Book Publishers, Inc., 1952.

A Textbook of Orthopedics; with a Section on Neurology in Orthopedics. By M. Beckett Howorth, M.D. In association with Fritz J. Cramer, M.D., A. Wilbur Duryee, M.D., Donovan J. McCune, M.D., J. William Littler, M.D., and Walter A. Thomson, M.D. Philadelphia and London: W. B. Saunders Co., 1952.

Rheumatic Diseases; Based on the Proceedings of the Seventh International Congress on Rheumatic Diseases. Prepared by the Committee on Publications of the American Rheumatism Association. Charles H. Slocumb, M.D., Chairman. Philadelphia and London: W. B. Saunders Co., 1952.

Text-Book of Orthopaedic Medicine; Treatment by Manipulation and Deep Massage. Vol. 2. By James Cyriax, M.D., B.Ch. (Cantab.). New York: Paul B. Hoeber, Inc., Medical Book Department of Harper & Brothers, 1951.

Urological Pathology. By Peter A. Herbut, M.D. Vols. 1 and 2. Philadelphia: Lea & Febiger, 1952.

Early Care of the Seriously Wounded Man. By Henry K. Beecher, M.D. Springfield, Ill.: Charles C Thomas, 1952.

Geburtshilfliche Operationslehre. By Prof. Dr. Karl Burger. Berlin, Goettingen, Heidelberg: Springer-Verlag, 1952.

A Practical Handbook of Midwifery and Gynaecology for Students and Practitioners. By W. F. T. Hautain, O.B.E., M.C., B.A., M.B., B.Ch., F.R.C.P.Ed., F.R.C.S.Ed., F.R.C.O.G., and Clifford Kennedy, M.B., Ch.B., F.R.C.S.Ed., F.R.C.O.G. Including a Section on the Management of the Infant and Neo-Natal Conditions. By J. L. Henderson, M.D., F.R.C.P.Ed. 4th ed. Edinburgh, London: E. & S. Livingstone Ltd., 1952.

Joll's Diseases of the Thyroid Gland. By Francis F. Rundle, M.D., F.R.C.S. 2nd ed. New York: Grune & Stratton, Inc., 1951.

Signs and Symptoms; Applied Pathologic Physiology and Clinical Interpretation. Edited by Cyril Mitchell MacBryde, A.B., M.D., F.A.C.P. 2nd ed. Philadelphia, London, Montreal: J. B. Lippincott Co., 1952.

Zwanglose Abhandlungen auf dem Gebiete der Frauenheilkunde. Vol. 12. Der muskulaere Schiefhals beim Neugeborenen. By Dr. Med. Habil. Helmut Kastendieck. Leipzig: Georg Thieme, 1952.

The Musculoskeletal System; a Symposium Presented at the Twenty-Third Graduate Fortnight of the New York Academy of Medicine, October 9 to 20, 1950. Edited by Mahlon Ashford, M.D. New York: The Macmillan Co., 1952.

CLINICAL CONGRESS OF AMERICAN COLLEGE OF SURGEONS

ALTON OCHSNER, New Orleans, *President*
HAROLD L. FOSS, DANVILLE, Pennsylvania, *President-Elect*

PRELIMINARY PLANS FOR THE 38TH CLINICAL CONGRESS, THE WALDORF-ASTORIA, NEW YORK, SEPTEMBER 22 TO 26, 1952

PLANS for the 1952 Clinical Congress are sufficiently far advanced to justify the prediction that the meeting, to be held September 22 to 26, in The Waldorf-Astoria Hotel, New York, will not only equal but possibly surpass previous Congresses in the high quality of scientific content and clinical interest which has come to characterize these programs.

Registration is expected to approach the 10,000 mark this year, topping the high 8,216 achieved at the San Francisco meeting and the previous record number of 8,986 who attended the 1950 meeting in Boston. A welcome feature this year will be the centering of scientific sessions and exhibits in the one major hotel, The Waldorf-Astoria, with some meetings at the Belmont Plaza, across the street, and the Biltmore, also nearby.

General plans for scientific sessions will be similar to those of recent Clinical Congresses, except in the case of the gynecology and obstetrics sessions. The last Clinical Congress included five sessions of primary interest to obstetricians and gynecologists. The 1952 Congress will further emphasize this field. A three day program of separate sessions for this specialty is being planned by the Advisory Council for Gynecology and Obstetrics. Surgeons on the eastern seacoast are now having their surgical procedures filmed for viewing at the Congress, to be shown in the Grand Ballroom of The Waldorf-Astoria. The increasingly popular ciné clinics are sponsored by Davis & Geck, Inc. The Advisory Committee on Programs has selected the subjects and the Committee on Medical Motion Pictures of the College is correlating the filming. Color television of operative procedures, probably from Presbyterian Hospital, will be transmitted to The Waldorf-Astoria. Sponsored by Smith, Kline & French Laboratories of Philadelphia, this will be the fourth demonstration of color television at a Clinical Congress.

This will be the seventh time that the Clinical Congress will have been held in New York. The third Congress was the first to be held there, in 1912, using the old Waldorf-Astoria as headquarters. Later Clinical Congresses were held in New York in 1919, 1924, 1931, 1938, and 1947.

COMMITTEE ON ARRANGEMENTS

The New York Committee on Arrangements for the Clinical Congress is composed of the following Fellows:

Frank Glenn, *Chairman*
Robert H. Wylie, *Secretary*
Henry W. Cave, *Member, Board of Regents*
George H. Humphreys, *Television Chairman*
Herbert Willy Meyer, *Public Relations Chairman*

Albert H. Aldridge	William F. MacFee
Frederic W. Bancroft	S. W. Moore
Frank B. Berry	John H. Mulholland
Thomas M. Brennan	W. Barclay Parsons
E. Jefferson Browder	Howard A. Patterson
Alexander Brunschwig	Brittain F. Payne
George F. Cahill	Algernon B. Reese
Ralph Colp	Howard C. Taylor
Clarence Dennis	James E. Thompson
Merrill N. Foote	Samuel A. Thompson
J. William Hinton	T. Campbell Thompson
Cranston W. Holman	Arthur S. W. Touroff
Marvin F. Jones	Preston A. Wade
Robert H. Kennedy	James M. Winfield

OFFICIAL MEETINGS

The opening evening session of the Clinical Congress in New York will be devoted to the Presidential Meeting, at which the officers-elect will be installed. Dr. Alton Ochsner of New Orleans, President, will preside and will deliver

the Presidential Address. Dr. Harold L. Foss of Danville, Pennsylvania, will be installed as President for the year 1952–1953. The seventh Martin Memorial Lecture will also be included in this program.

The annual Convocation will be held on the final evening, Friday, September 26. The formal initiation ceremonies and the presentation of the Fellowship Address by Sir Cecil Wakeley, President, Royal College of Surgeons of England, will constitute the program. The annual meeting of Fellows of the College will be held Thursday, September 25, in the Grand Ballroom of The Waldorf-Astoria.

EVENING SCIENTIFIC SESSIONS

General scientific sessions, devoted to symposia or to individual subjects of timely interest, will be held on the evenings of Tuesday, Wednesday, and Thursday. The annual Oration on Trauma, formerly known as the Fracture Oration, will be a part of the Wednesday evening program.

PANEL DISCUSSIONS

There will be panel discussion sessions on the afternoons of Monday, Tuesday, Wednesday, Thursday, and Friday. While the sessions of the first four days are planned primarily for general surgeons, many of the subjects to be discussed are of equal interest to surgeons who are working exclusively in the special fields of surgery. On Friday afternoon, separate panel discussions will be held simultaneously for the following specialties: gynecology and obstetrics, neurological surgery, orthopedic surgery, plastic surgery, thoracic surgery, and urology.

SPECIAL SYMPOSIA

On three days there will be special symposia, one devoted to trauma, one to cancer, and one to graduate training.

PROGRAMS FOR OPHTHALMOLOGY, FOR OTOLARYNGOLOGY, AND FOR GYNECOLOGY AND OBSTETRICS

A three day program, consisting of symposia and panel discussions, is being planned for each of these specialties by their respective advisory councils.

FORUM ON FUNDAMENTAL SURGICAL PROBLEMS

The Surgical Forum Committee plans a program consisting of twelve Forum sessions devoted to reports of recent research work in general surgery and the surgical specialties. These sessions will include approximately 150 papers which the Forum Committee will have selected as being of special interest to surgeons. In the last Clinical Congress, reports of research work in four special fields of surgery made possible the devoting of one Forum program primarily to each of these specialties. A similar plan will be followed this year, if sufficient important research work in the surgical specialties is received by the Forum Committee.

POSTGRADUATE COURSES

Five postgraduate courses were included in the programs of the last two Clinical Congresses. Seven courses will be given at the New York Congress. Each will occupy the forenoons of Tuesday, Wednesday, Thursday, and Friday. The fields in which courses will be given are the following:

Gynecology and obstetrics
Management of fractures
Nonmalignant diseases of the gastrointestinal tract
Surgical aspects of pulmonary disease
Nutrition and preoperative and postoperative care
Trauma of the skull and spine
Vascular diseases

MEDICAL MOTION PICTURES

The latest available pictures on surgery and related subjects will be presented in the film exhibition. Special showings will be arranged of films in the fields of ophthalmology and otolaryngology. The Committee on Medical Motion Pictures is now choosing films for the Congress. Pictures that have been recently produced should be forwarded to the College for immediate review as it is the policy to include only those films which were submitted in time to obtain approval by the Committee. Deadline for this approval is July 30.

HOSPITAL CONFERENCE

Whether or not a hospital conference will be held will depend upon the progress made by the Joint Committee on Accreditation of Hospitals. The decision will be announced later.

ADVANCE REGISTRATION

Surgeons who wish to attend the Clinical Congress should register in advance. This will greatly expedite the procedure of registering. No registration fee will be charged Fellows whose dues are paid to December 31, 1951. For endorsed candidates, the fee will be $5.00. Non-Fellows, who after individual consideration are permitted to register, will pay a fee of $10.00. No registration fee will be required of Initiates of the class of 1952. Official registration blanks, hotel reservation forms, and other details have been sent to all Fellows.

HOTEL RESERVATIONS

It is desirable that hotel reservations be made as early as possible, and for this purpose the official reservation form should be completed and returned to the New York Convention and Visitors Bureau, 500 Park Avenue, New York 22, New York. Ample first-class hotel accommodations have been assured. It is important in any communication about hotel reservations that reference be made to the Clinical Congress of the American College of Surgeons. All communications relative to housing should be directed to the convention bureau named above and not to the hotels.

POST-CONVENTION TOUR

The College has appointed Mr. Leon V. Arnold, travel consultant in New York, to act as official host for a post-convention cruise to Bermuda. In all probability there will be two cruises leaving New York on Saturday, September 27, immediately following the Congress. Both cruises will be on the Furness Line, on the

Ocean Monarch—9 day cruise to Bermuda and Havana. Minimum rate about $225.00.

Queen of Bermuda—6 day cruise to Bermuda. Minimum rate about $186.00.

Further information on these two cruises will be included in the brochures pertaining to the Congress, to be mailed to Fellows early in May. For advance information prior to this mailing Fellows may write to Mr. Leon Arnold, Hotel Halley, 36 Washington Square, New York 11, New York.

SCIENTIFIC AND TECHNICAL EXHIBITS

Forms to be used in applying for scientific exhibit space at the Clinical Congress in New York, September 22 to 26, may be obtained by addressing a request to Walter E. Batchelder, M.D., Chairman, Committee on Scientific Exhibits, American College of Surgeons, 40 East Erie Street, Chicago 11, Illinois. Requests for this form will be accepted through June 30. Limited space at The Waldorf-Astoria, headquarters for the Congress, necessitates restricting exhibits to subjects of greatest interest to the surgeons, and submitting applications at an early date is essential.

The technical exhibit, to be housed in The Waldorf-Astoria Hotel, will provide an extensive display of surgical and hospital supplies and equipment by manufacturers and distributors. The leading pharmaceutical firms will also be represented, as well as displays of new medical books and journals by leading publishers.